REPORT

OF THE

COMMISSIONER OF AGRICULTURE

FOR

THE YEAR 1877.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1878.

ORDER TO PRINT.

CONGRESS OF THE UNITED STATES,
In the House of Representatives, June 6, 1878.

Resolved by the House of Representatives (*the Senate concurring*), That there be printed three hundred thousand copies of the Report of the Commissioner of Agriculture for 1877; two hundred and twenty-four thousand copies for the use of the House of Representatives, fifty-six thousand copies for the use of the Senate, and twenty thousand copies for the use of the Department of Agriculture: *Provided, however*, That the number of pages of said Report shall not exceed six hundred.

Attest:

GEO. M. ADAMS, *Clerk*.

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REPORT

OF THE

COMMISSIONER OF AGRICULTURE.

DEPARTMENT OF AGRICULTURE,
Washington, November 15, 1877.

To the President of the United States:

SIR: By your instruction, and under your direction, I assumed control of the Department of Agriculture at the beginning of the present fiscal year.

An examination of the current reports of correspondents of the department encouraged me to anticipate an unusually favorable harvest, in every direction, from the growing crops of our widespread agricultural domain. These hopes have been fully realized, and I am enabled to state that, with scarcely an exception, the varied products of the country have yielded almost unparalleled returns, affording gratifying evidence not only of the available extent and fertility of our arable lands, but of increasing industry and prosperity among our agricultural population, and of intelligent devotion to the important interests of husbandry.

In presenting this encouraging view of the results of agricultural labor during the present year, there is occasion to congratulate our people upon the success of that industry which lies at the foundation of national prosperity. But with all these evidences of prosperous industry, we may not hope to take that rank among the producers of the world to which we are entitled until we have exhausted all efforts to produce within our own borders, and as a result of our own industry, everything now imported from other nations, which can be obtained from the careful cultivation of our own productive soil, which, extending through so many climes, with its wonderful diversity, offers unparalleled opportunities for the agricultural industries of a self-sustaining, prosperous, and happy nation.

An examination of the Report of the Bureau of Statistics of the Treasury Department furnishes a suggestive exhibit of our annual importation of the agricultural products of other lands. The following are among the articles imported that can and ought to be produced in the United States, with the value thereof:

Articles.	Quantity.	Value.
ARTICLES FREE OF DUTY.		
Peruvian bark (Calisaya, &c.) ... pounds..	5,744,765	$1,293,400
Bark used for tanning ...	...	181,826
Cork-bark, unmanufactured ...	...	606,169
Coffee ...	339,789,246	56,788,997
Eggs ...	4,903,771	630,393
Indigo ...	959,139	794,999
Madder ...	2,911,958	151,005
Paper-materials ...	112,447,584	3,854,046
Tea ...	62,887,143	19,524,166
Total ...	...	83,827,992
DUTIABLE ARTICLES.		
Barley ... bushels..	10,285,957	7,887,886
Barley-malt ... bushels..	286,930	252,622
Rice ... pounds..	71,561,852	1,693,547
Hemp ... tons..	17,979	2,247,540
Jute and other grasses ... tons..	60,368	2,384,881
Flax-seed ... bushels..	2,755,726	3,859,496
Silk ...	...	23,745,967
Straw and palm-leaf ...	...	1,856,674
Wines ...	...	4,754,110
Wool, unmanufactured ...	44,642,836	8,247,617
Total ...	...	56,930,340

The value of sugar and molasses entered for consumption in three years is as follows:

Year.	Values.	Duties.
1874 ...	$92,614,832	$34,860,278
1875 ...	82,209,853	37,157,245
1876 ...	75,742,466	41,898,575
	250,567,151	113,916,098
Annual average for three years ...	83,522,383	37,972,032
FRUIT AND NUTS.		
Currants ...	856,425 62	209,110 61
Lemons and oranges ...	3,412,027 45	682,405 50
Almonds ...	463,106 86	240,207 89
Prunes and plums ...	2,333,949 00	553,660 77
Raisins ...	2,425,277 14	805,526 63
All other fruits and nuts ...	2,424,480 44	624,318 20
	11,915,266 51	3,115,229 60

Thus it will be seen that $236,295,981, besides the additional expense for freight and commissions, are paid annually for imports, all of which could and should be saved to our people.

Among the imported products of other nations which absorb the capital, retard the industry, and depress the commercial prosperity of the country, that which holds the first importance is the item of sugar, for which we are paying to foreign producers nearly a hundred millions of dollars annually, while we have neglected our natural facilities for supplying our own market and contesting the world's market with this production. Nor ought it to lessen our anxiety in view of this anomalous fact, that, having made freedmen of our slaves, a great portion of the vast amount we thus contribute to foreign industry goes to sustain and support the slave labor of Cuba, a country which takes from us very little, if anything, except gold, in exchange for her abundant supplies of sugar and tobacco.

It is of the greatest importance in the present stagnant condition of the labor and business of the country that the millions of gold thus paid to foreign nations for sugar and other articles of consumption, which habitual use has made necessary for us, and which we have such abundant natural facilities for producing at home, be saved to our people. Every pound of sugar needed for our home consumption can be produced cheaply on our own territory. The saving of the vast amount now expended in the importation of this staple is, however, but one of the important results which will follow its home production.

The sugar-interest of the country reaches every cupboard in our broad land, and is intimately connected with every branch of the inter-State trade and commerce of the republic; and if the manufacture of sugar be encouraged and developed to the extent of supplying our home demand with home-grown sugars, importations will necessarily cease, and the perpetual flow of American gold to countries with which we have comparatively no trade will be arrested, specie resumption will be assured, confidence restored, and the material prosperity of the country will advance with renewed energy and power under the changed condition of production in this single article of universal consumption.

The great West will purchase the domestic sugars of the Gulf States or California, and pay in flour, whisky, corn, pork, stock, and mechanical implements. Pennsylvania will buy, and pay in coal, iron, and petroleum. The New England States will pay in clothing, shoes, hats, jewelry, cutlery, and other products of their skilled mechanical labor; and the distribution of the 200,000 tons of sugar over this broad land, every year, will give active employment to an army of common carriers and middlemen.

Some hundreds of thousands of acres of the best sugar-producing lands lie on the Lower Mississippi, inundated through the broken levees by every overflow of that great river, and no power except that of the general government is adequate to protect this wide expanse of fertile territory, and give confidence to capital and labor to again occupy and cultivate it.

Individuals, corporations, counties, and States have exhausted themselves in fruitless efforts to protect these lands from overflow, and to restrain the Mississippi within its proper boundaries and navigable channel.

It is a *national* work, for a *national* purpose, and, as it seems to me, a *national* duty at this time to take in hand and push to a speedy conclusion the re-establishment of the broken levees, and the making of such provision for their maintenance as shall permanently secure the valuable industries that will immediately reoccupy the lands now subject to overflow, and for this reason alone abandoned.

It is claimed by the sugar-planters of Louisiana that the present tariff does not protect the interests of the American producer of sugar in the slightest degree, but that it discriminates against the planter, and gives to the sugar-refiners, who are less than fifty in number in the whole country, a monopoly of the markets.

Such protection and encouragement as the older nations of Europe have always extended to their sugar-interests would apply not alone to the protection of cane-sugar, but also to the manufacture of the beet-sugar (which now in Europe competes successfully with cane-sugars), and the manufacture of which, it is hoped, may soon secure a foot-hold in those sections of the United States where the beet is found to be most rich in saccharine.

I am now engaged in a careful research as to soil and conditions necessary in this country to produce beets or other vegetables, rich enough in saccharine matter to warrant the expenditure of capital in the machinery necessary to the successful manufacture of sugar. Thus far men of means have not seen sufficient assurance of profit to tempt any increase of the industry over past years, and but one manufactory of beet-sugar is now known to be in successful operation.

An attempt on a moderate scale, but with a degree of intelligence and zeal which promises to demonstrate whether success is possible, is now being made in New Jersey, as a preliminary step toward an earnest effort to secure the production of sugar to satisfy at least our home demand by an increase of the growth of the sugar-cane. I entered into an extended correspondence with sugar-planters, chiefly in Louisiana, with very encouraging results, as will be seen from special report No. 1, hereto appended. The liveliest interest has been excited in the subject, and, with reasonable encouragement on the part of the government, the most gratifying and important results may be confidently anticipated.

Among the good results of the former distributions of plants is the knowledge that the Chinese tea-plant can be, and indeed already is, successfully grown in the States of North Carolina, South Carolina, and Georgia, and in other parts of the United States of similar climate.

I have made as thorough inquiry as time would permit as to the facts of tea-culture in this country, and am led to believe that, with proper encouragement, within a few years American tea can be put successfully upon the markets of the world.

In furtherance of this interest I have caused to be prepared an extended paper on the cultivation and preparation of American tea, which will be found in this report, and to which I beg leave respectfully to invite your attention.

I have had numerous applications from communities favorably located for plants with which to commence the culture of the fragrant herb, and officers of certain agricultural associations have eagerly volunteered to give special attention to the culture by their respective granges and societies.

To meet this encouraging interest expressed in South Carolina and Georgia, I have purchased all the tea-seed that could be obtained from plants grown in this country, and will, as far as the very limited opportunity offered by our propagating-beds permits, provide tea-plants for early distribution the coming season. It is expected that some hundreds of thousands of tea-plants will be sent out during the season of 1878, and that they may be grouped in the most favorable localities, and within four or five years serve to demonstrate the practicability of providing our people with a better article of tea than they now are able to obtain, and the possibility of saving to our country from nineteen to twenty millions of dollars in coin, which annually finds its way into the coffers of British merchants, who have substantially a monopoly of Chinese trade.

A brief notice of the services rendered by the different branches into which the department, for convenience and greater efficiency, is divided, will afford a general view of the specific operations of the past year.

The Division of Horticulture and Arboriculture is one of the most important of the component branches of the department, and contributes materially to the benefits which the public derive from its workings. The laying out of the grounds, the establishment of an extended arboretum, and the cultivation of exotic plants have progressed as the means and the land within the control of the department have allowed. The propagation of plants for distribution is exclusively confined to those species and varieties which are of economic value, those of merely ornamental interest being increased only to the extent necessary for the decoration of the grounds. Although the operations of the horticultural division have been seriously restricted by insufficient appropriations, yet, by an exercise of strict economy, the supply of plants for distribution has been partly kept up. This supply is the result of manual labor, and when that is abridged the propagation and increase of plants are, as a matter of course, reduced in proportion. This circumstance is very unfortunate, as it partially paralyzes the efforts of the department by depriving it of the ability to respond to the great interest that it has awakened in the introduction and cultivation of such new plants as yield products of commercial importance.

The collection of economic exotic plants also awaits completion. As it now stands, it is the most complete of its kind in the country, containing many plants that cannot be duplicated here. It exhibits the various food, fiber, varnish, gum, and medicine yielding plants of note, and furnishes material for physiological, pharmaceutical, historical, and other educational purposes, to those who desire such assistance.

Collections for agricultural institutions are furnished when desired, so far as duplicates can be made available, and of such species as are considered worthy of introductory trial. With a view to their commercial value in this country, extensive numbers are propagated and distributed in localities where it is presumed they will succeed.

The greenhouses of the department ought to be materially enlarged; they are at present altogether too small for the present imperative needs of the department, to say nothing of prospective demands, which are too important to be overlooked.

The arboretum, which was commenced several years ago, has also been arrested in its completion; no new additions, of any moment, have been made for the past two years. This is much to be regretted. The great amount of attention that is justly directed to the planting of forests is measurably assisted by the opportunities afforded in making appropriate selections from observations of the growing plants where a criterion can be reached as to their comparative rapidity of growth, and their suitableness in other respects for particular uses in particular localities. The collection is claimed to be the best assortment of trees that is to be found in the country, comprising both native and foreign kinds, so arranged as to give the greatest opportunities for comparison of their respective values, whether in regard to purposes necessary for the amelioration of climates, the production of fuel, or for use in the arts and constructive economy.

In the *Botanical Division*, which includes the formation of a herbarium for systematic study and illustration of the vegetable kingdom, there has been a favorable state of progress. Several thousand specimens of plants have been added to the herbarium, which is gradually becoming what it ought to be, a complete representation of the vegetable productions of the United States, and incidentally of other countries. The collection has been cramped for want of sufficient room, but provision has now been made to enlarge the space devoted to this purpose.

The following points are kept in view in this division, viz:

1st. The improvement of the herbarium by the addition of new species as rapidly as the means provided will allow.

2d. The replacement of defective and imperfect specimens by good and characteristic ones.

3d. The distribution of duplicate specimens to institutions of learning, and particularly to our agricultural colleges.

A full and complete herbarium of American plants at the seat of government is a necessity, not only in a scientific point of view, but in order properly to answer the numerous questions of a practical and economic character which are daily presented to this department as to the name, nature, and properties of plants from all parts of the country.

The source of supply of specimens has been mainly the collections of the various scientific surveys of the government. If proper regulations are secured, the supply through this channel may be largely increased both in amount and quality, and our means of supplying institutions of learning be greatly enlarged. During the year just past only one addition to the herbarium has been made by purchase, viz., that of a collection of some 600 species of the plants of Southern California and Arizona. During the late Centennial Exposition we became indebted to various foreign nations for contributions to our herbarium and museum, and an exchange of contributions was earnestly desired by such foreign nations of American productions, especially of our native forest-woods. We have, during the past year, responded to these desires by the following distributions:

To the Royal Botanic Garden at Kew, England, one set of specimens, consisting of four boxes, each of about 150 pounds weight.

To the Imperial Botanic Garden, St. Petersburg, one set of boxes.

To the Museum National de Rio de Janeiro, Brazil, one set of four boxes; also one box of botanical specimens.

To the Colonial Museum, Melbourne, Australia, two boxes of wood-sections.

To the Tokio Museum, Tokio, Japan, two boxes of wood-sections and one box of 400 species of plants.

To the Portuguese Government, two boxes of wood-sections and one box containing about 400 species of botanical specimens.

To the Spanish Government, through J. Jordena, of Morera, Spanish commissioner on forestry, one box of botanical specimens, chiefly of the forest-trees of the United States.

To the Adelaide Museum, Adelaide, South Australia, one box of botanical specimens, embracing about 600 species.

In our own country the following distributions have been made:

To Harvard University, one set of wood-sections.

To Saint Louis Academy of Sciences, one set of wood-sections.

To Yale Scientific School, one set of wood-sections.

To Cornell University, one set of wood-sections.

To Illinois Industrial University, one set of wood-sections.

To the Park Commission of Baltimore, one set of wood-sections.

To the Philadelphia Permanent Exhibition, one set of wood-sections.

In addition to these distributions, we have sent packages of plants to Wesleyan University, Bloomington, Ill.; to D. C. Eaton, professor of botany, Yale College, Conn.; to the normal school, Millersville, Pa.; and several packages to individuals, in exchange.

The *Entomological Division* has, as usual, been employed in answering a large number of letters in regard to names, habits, and especially the remedies now in use for the most destructive of our insect pests.

Among these have been a number of inquiries from foreign governments and private individuals in foreign lands in regard to the "*Phylloxera*," or grape-root gall-louse, and the "*Doryphora decem-lineata*," or Colorado potato-beetle, which insect has already crossed the ocean. The western grasshopper, "*Caloptenus spretus*," which was feared in the earlier part of the season, has done little damage comparatively, and but few letters were received concerning it.

Notes have been made on the habits of insects reared at the department for determination as to their habits.

The cabinet has been augmented by the addition of two or three small collections, principally from the West.

The Centennial collection of economic insects, arranged with regard to their injury or benefit to particular farm crops or products, has been displayed in the cabinet-rooms, making an attractive and instructive exhibition.

No new insects especially injurious to vegetation have been added during the year to the already long list.

The collection of birds destructive to agriculture or beneficial by destroying insect-foes has been relabeled and renamed according to the latest authorities. This collection, accompanied by a series of boxes containing the contents of the stomachs of the birds, is intended to comprise a few of our noxious and beneficial kinds, as a guide to the farmer to show the species which should be especially preserved.

A new gallery has been added to the museum hall, giving about 3,000 square feet of additional floor-space. The cases used by the department at the Centennial Exhibition have been placed in position here. These have been thoroughly renovated, and furnished with new shelving where required, to accommodate the large additions to the museum that were collected for exhibition in Philadelphia, as well as the still larger collections of agricultural products from the Centennial presented by foreign governments. The foreign donations have been unpacked as far as possible, and the cases in the new gallery filled with the specimens.

Many articles still remain unpacked for the want of funds necessary to purchase proper materials for their exhibition.

In view of the fact that it is almost an impossibility to keep insects from grain and wool samples in bulk for any great length of time, even when in bags, it is desirable that an appropriation be made as early as possible, that the specimens may be put beyond the reach of noxious insects and placed in the museum hall.

The work of cataloguing the specimens has commenced, there having been no previous catalogue. The Centennial Exhibition enabled the department to complete its collections more fully, and as the museum has more than doubled in size and in number of specimens, a catalogue becomes a necessity.

The *Chemical Division* has been employed in—

1. Continuation of examination of bat-guanos from the Southern States.
2. Analyses of shell-marls.
3. Investigation of American sumac: (*a*) To determine the best time during the season for collection to secure the highest percentage of tannic acid; (*b*) the causes producing the wide difference in the market-values of the American and Sicilian products, and a ready and sufficient means for their removal; (*c*) percentage of tannic acid in samples taken from the various stages of the process employed in its preparation for the market.
4. Investigation of the natural causes which may modify the supply of mineral nutrition to plants, and their influence upon the production of mildew and rot.

5. Examination of roots for the determination of the presence or absence in them of the so-called vegetable pepsin.

6. Examination of beets for the determination of the percentage of sugar they contain.

The continued examination of bat-guano has afforded results confirming those obtained by the former analysis and proving the wealth of native fertilizing material existing in the South. Indeed, calculations based upon the reported extent of the deposits and the proportion of valuable constituents they are found by analyses to contain, show the aggregate value of this material that may be considered in sight to amount to about $20,000,000. Surely Southern cultivators need no urging to induce them to take advantage of these stores of fertility for their poor or exhausted soils.

The analyses of shell-marls have been such as the time that could be allotted to them would allow, and were confined entirely to the mere estimation of carbonate of lime, phosphoric acid, and potassa they contain.

The results obtained in the investigation of American sumacs are of an exceedingly satisfactory character, and may be summarized as follows:

1st. The time for collection to secure the highest percentage of tannic acid is during the month of July.

2d. The wide difference in the market-values of the American and Sicilian products is due to the yellow coloring matter contained in the former.

3d. In order to get rid of this troublesome matter, and secure a quality of sumac of technical value equal to the Sicilian, the leaves should be collected during the month of June. Upon these results may be based rules for the classification of sumac in the markets, so that the June collections may be applied to the tanning of delicately-colored leathers, while the July collections may be employed in the manufacture of dark-colored leathers and for dying dark-colored goods. By this means the American product, which is obtained from an entirely spontaneous growth upon lands that would otherwise be worthless, may find much wider appreciation and thus prevent the large importations of the foreign product, the cost of which annually aggregates about $700,000 to consumers.

The investigation relating to the natural causes in the soil tending to the production of mildew and rot in plants has afforded results which, before they can be accepted, must be duplicated. The experiments made, which were entirely of a preliminary character, proved exceedingly interesting, and have opened up a fruitful field for extended study and research.

The increasing interest in the production of sugar-beets and the manufacture of sugar from them, and the earnest endeavors to bring about a permanent establishment of this important industry throughout the United States, has led to the estimations of the sugar percentage found in beets from crops grown in various localities, and most of them have proven the capability of American soil to produce beets of good quality.

The work projected and partly under way consists of—

1st. Further investigations of physical causes which may influence the production of mildew and rot.

2d. Experiments on the industrial application of the coloring matter of the coleus plant to textile fabrics.

3d. Examination of the root of the lignum-vitæ for the determination of its value as a detergent for cleansing textile fabrics.

4th. Analysis of the various native Southern grasses for the determination of their value for cattle-food.

5th. Analysis of specimens from a natural deposit in Maryland, supposed to contain large quantities of phosphate of lime.

6th. Examination of certain Florida soils.

7th. An examination of the American wheats, for the determination of their value for the manufacture of flour that will not readily ferment in warm climates, is under consideration, and will be prosecuted whenever the chemical force of the department will admit. With but one chemist and one assistant, and the constantly-increasing miscellaneous work that must be attended to, this now appears almost hopeless.

During the present year the *Microscopist* of the department visited some of the principal cranberry districts of New Jersey, for the purpose of investigating the causes of diseases which for some years past have seriously affected cranberry-vines in that State, causing much of the fruit to prematurely decay. He also visited localities in this State where the grape is extensively grown, and made a partial microscopical investigation for the purpose of determining the cause of rot in the Concord grape.

During the season of harvesting the attention of the department was called to the fact of the partial failure of the wheat-crop in several localities in Northumberland County, Virginia. As this failure could not be traced to any of the known causes of diseases which affect this cereal, the Microscopist was directed to proceed to the locality and make an examination of the plant and soil with a view of ascertaining the cause of such failure. Such facts as were elicited in these various investigations have been submitted to the department.

The *Statistical Division* has been employed in—

1st. The record and tabulation of foreign and domestic statistics of agriculture, derived from national and State departments and the various grades of rural societies and experimental schools.

2d. The collection of statistics of distribution of the products of agriculture, the current price of such products in primary markets, and the cost of transportation and exchange.

3d. Statistical analysis of such information and deductions illustrative of the causes or change in production, its economic tendencies, and comparative profits.

4th. An original crop-reporting system, including a corps of correspondents or reporters in the principal counties.

The work of the past year has been obstructed by a reduction of appropriations, which have been insufficient for the payment of the usual labor of record and compilation in the office. The demand for information by members of Congress, boards of trade, agriculture, and rural and technical writers has been met as fully as possible with this lack of facilities.

The crop records of the present year have been of unusual interest and importance. At the outset complaints were made of the lateness of the planting season and slow growth of corn on account of an excess of rain and a comparatively low temperature. Early reports were speedily followed by accounts of general and rapid improvement; prompt replanting of wet areas and cleaner cultivation; and later returns indicated higher condition than in 1876, promising, with an increase of acreage, at least 50,000,000 bushels, or a crop not less than 1,340,000,000 bushels, the largest ever grown. The records of this crop illustrate the importance of yearly estimates, which show that the average yield ranges from 20 bushels in a poor crop to 30 in a large one, from 768,000,000 bushels in 1867 to 1,340,000,000 in 1875, and that the smallest crop yields the greatest aggregate in money. The price per bushel has ranged from 79.5 cents in 1867 to 37 cents in 1876, while the average for ten years has been 58.2 cents, and the average yearly aggregate $538,442,000. The present is the third large crop in succession following small crops, but the value of 1,300,000,000 bushels differs only in a slight degree from the total valuation of a crop of 900,000,000 bushels.

The wheat-crop of the present year has been promising in a high degree during the entire season. Fears of grasshopper invasions were early dispelled, except in a few counties in Minnesota. The losses from winter-killing, the fly, chinch-bug, grasshoppers, rust, smut, &c., have this season been far less than usual. The heaviest production is in the section of the lightest yield last year (the Northwestern or spring-wheat States), whose product fell off 36,000,000 bushels. The aggregate in Wisconsin, Minnesota, Iowa, and Nebraska is double that of last year, and nearly 20,000,000 bushels greater than in 1875. The entire crop promises to exceed that of last year by 70,000,000 bushels, leaving 100,000,000 bushels for exportation, with a surplus remaining above the actual requirement of consumption. Other crops have generally been good. A comparison of the crops of the past three seasons is given, as follows, the figures for the present year being preliminary and subject to revision in completing and perfecting the estimates of the year:

Crops.	1877.	1876.	1875.
	Bushels.	*Bushels.*	*Bushels.*
Corn	1, 340, 000, 000	1, 283, 827, 500	1, 321, 069, 000
Wheat	360, 000, 000	289, 356, 500	292, 136, 000
Rye	22, 000, 000	20, 374, 800	17, 722, 100
Oats	390, 000, 000	320, 884, 000	354, 317, 500
Barley	35, 000, 000	38, 710, 500	36, 908, 000
Potatoes	140, 000, 000	124, 827, 000	166, 877, 000

Among the "industrial crops," cotton, the most prominent, promised 4,500,000 bales in October, but the weather has since been unfavorable, and may lead to a smaller percentage of production. A bad picking-season to the end of December might reduce the product half a million bales.

The tobacco-crop promises to be a large one, and may reach a product of 440,000,000 pounds, about 60,000,000 above the estimated product of last year.

The season has been unfavorable for fruit of most kinds. The main crop, that of apples, is a comparative failure, nowhere found in abundance, greatly reduced in yield, and high in price. Other fruits are also reduced in yield. The grape-crop suffered in an unusual degree from rot, and the wine product will be reduced in the affected districts.

The products of the dairy are abundant, and the prices are fairly remunerative. A tendency to enlargement of this industry in the West is manifest in a marked degree.

There has been a fair prospect for an increase in the product of sugar over that of last year, but in consequence of bad weather for harvesting and securing the cane, it is too early to say whether the yield will be equal to that of last year.

The distribution of a miscellaneous assortment of seeds to the farmers on the frontier, whose crops were destroyed by the locust or grasshoper, was of the greatest benefit to those poor and destitute people, who were thus enabled to remain on their farms, and to secure enough of the fruits of the earth to eke out a living until the terrible scourge had passed away, or another season had arrived with better hopes of successful culture. In the planting of trees, and the consequent increase of insectivorous birds, as well as in the ingenious devices which have been adopted by the farmers of Minnesota and Kansas the past year, the most efficient means will be found of keeping under control a pest which has been more terrible than "an army with banners" since history has had a record.

Perhaps the earliest account of any appearance of the grasshopper west of the coasts of Europe or Africa is that given in the History of Jamaica, by Sir Hans Sloane, in which a life-size drawing is given of the locust or grasshopper that fell on the deck of a vessel many leagues from land. The insect here described was of a species now known as the Barbary locust, and was larger than that which has ruined so many of the farmers of the West during the past five years, and the ravages of which, we may expect, will be repeated from time to time until the knowledge and ingenuity of our people shall master the secret of their birth and habits, and control the breeding-grounds, or destroy the predaceous hordes before they can have time to work fatal mischief to the crops.

The following tabular statement will exhibit the extent of this distribution to the grasshopper districts in detail:

Tabular statement showing the quantity and kind of seed issued from the Department of Agriculture to States and Territories ravaged by the grasshoppers, under special appropriation of $20,000 of March 3, 1877.

Description of seed.	Nebraska.		Minnesota.		Kansas.	
	Senators and members.	Miscellaneous.	Senators and members.	Miscellaneous.	Senators and members.	Miscellaneous.
Vegetable .... papers..	121, 200	18, 550	321, 500	12, 185	135, 400	8, 735
Wheat .... quarts..	....	....	400	68	....	2
Barley .... do....	....	2	600	82	....	....
Buckwheat .... do....	....	....	....	....	314	2
Corn .... do....	1, 500	10	2, 044	40	1, 080	10
Pease .... do....	....	....	2, 060	8	....	....
Sugar-beet .... do....	....	2	600	....	16	6
Mangel-wurzel .... do....	....	2	600	....	16	6
Grand total	122, 700	18, 566	327, 804	12, 383	136, 826	8, 761

Description of seed.	Iowa.		Montana.	Dakota.		Colorado.	Total.
	Senators and members.	Miscellaneous.	Member.	Member.	Miscellaneous.	Senators.	
Vegetable .... papers..	198, 720	19, 890	7, 500	3, 000	58, 075	27, 135	931, 890
Wheat .... quarts..	....	10	....	....	....	....	480
Barley .... do....	....	....	....	....	2	....	686
Buckwheat .... do....	....	....	....	....	....	....	316
Corn .... do....	....	10	....	2	....	1, 000	5, 696
Pease .... do....	444	....	....	....	....	....	2, 512
Sugar-beet .... do....	350	....	....	2	....	....	976
Mangel-wurzel .... do....	350	....	....	....	....	....	974
Grand total	199, 864	19, 910	7, 500	3, 004	58, 077	28, 135	943, 530

In the *Seed Division*, which embraces the packing and distribution of seeds, the following tabular statement will show the extent and description of seeds distributed during the past year:

Tabular statement showing the quantity and kind of seed issued from the Department of Agriculture, under the general appropriation, from July 1, 1876, to June 30, 1877, inclusive; also amount issued under special appropriation to sufferers by grasshopper ravages.

Description of seed.	Varieties.	Senators and members.	Agricultural societies.	Statistical correspondents.	Miscellaneous.	Grasshopper ravages.	Total.
Vegetable .... papers..	326	221, 070	159, 100	235, 885	263, 155	931, 890	1, 811, 100
Flower .... do....	220	148, 770	220	155	153, 250	....	302, 395
Herb .... do....	9	150	....	....	235	....	385
Tree .... do....	15	306	398	315	2, 026	....	3, 045
Field seeds.							
Wheat .... quarts..	7	14, 454	16, 304	16, 004	5, 484	480	52, 726
Oats .... do....	5	5, 976	10, 982	10, 104	3, 554	....	30, 616
Barley .... do....	4	2, 416	8, 558	8, 154	696	686	20, 510
Rye .... do....	1	2, 408	....	418	246	....	3, 072
Buckwheat .... do....	1	270	2, 476	6, 146	432	316	9, 640
Corn .... do....	4	2, 230	3, 174	3, 758	759	5, 696	15, 617
Pease .... do....	1	16	....	....	34	2, 512	2, 562
Clover .... do....	4	1, 542	48	22	1, 093	....	2, 705
Grass .... do....	5	2, 492	1, 572	3 466	2, 870	....	10, 400
Sugar-beet .... do....	3	2, 914	469	244	253	976	4, 856

Tabular statement showing the quantity and kind of seed issued, &c.—Continued.

Description of seed.	Varieties.	Senators and members.	Agricultural societies.	Statistical correspondents.	Miscellaneous.	Grasshopper ravages.	Total.
Mangel-wurzel .... quarts..	3	2, 222	1, 124	859	216	974	5, 395
Rice .... do....	1	16	....	....	14	....	30
Sorghum .... do....	1	84	....	....	234	....	318
Millet .... do....	1	122	....	179	12	....	313
Broom-corn .... do....	1	32	138	400	81	....	651
Vetches .... do....	1	....	....	....	11	....	11
Rape .... half pints..	1	6	....	....	2	....	8
Tobacco .... papers..	4	42, 562	100	10	2, 726	....	45, 398
Opium poppy .... do....	1	200	....	....	182	....	382
Chufa .... do....	1	1, 540	....	....	3, 681	....	5, 221
Textiles.							
Cotton .... quarts..	4	682	1, 570	2, 627	581	....	5, 460
Jute .... do....	1	16	....	398	88	....	502
Hemp .... do...	1	....	....	....	4	....	4
Flax .... do...	1	8	....	....	....	....	8
Ramie .... papers..	1	....	....	....	144	....	144
Grand total	......	452, 504	206, 233	289, 144	442, 063	943, 530	2, 333, 474

This distribution, as will be seen, extends through the fiscal year ending with June, 1877, and includes, therefore, the fall planting of last year and the spring planting of the present year. While this distribution is believed to have been in many respects of great value to the country, it was found to possess some features that were not wholly legitimate. I have accordingly introduced some changes in the method of distribution, which will conform to the organic law, and result in a more beneficial working of the system.

It will be seen from the above table that the distribution embraced very many common vegetable and flower seeds, and finding no authority in the provisions of the organic law of the department for the distribution of these, or indeed any other description of seeds than those which were "new and valuable," I deemed it my duty to limit the distribution to such seeds as were clearly within the meaning of the law, having due regard to differences of climate and other agricultural conditions of the various sections of the country.

It will be observed, also, that a large portion of the seeds was issued to "miscellaneous" applicants, necessarily with little or no knowledge on the part of the department as to the claims of such applicants as *agriculturists*. This, it was believed, led to misapplication, abuse, and even fraud, in the use of seeds, and a more careful scrutiny has, in consequence, been exercised by confining the distribution to agricultural associations and colleges, permanent correspondents and agents of the department, and to such individuals as were known to be agriculturists, as distinctly defined by the law, which designates such persons, and such only, as the recipients of the bounty of the department With the latter object in view, measures were taken through members of Congress to ascertain the names of such farmers in the different Congressional districts as from their intelligence and experience would afford the best security for thorough, careful, and exhaustive trials of seeds under varied circumstances of soil and climate.

The changes in general which were conceived to be demanded for the more successful working of the department, and for bringing its action as far as possible into conformity with the terms of its organization, are indicated in the following circular-letter, which I took an early occasion to issue:

DEPARTMENT OF AGRICULTURE,
Washington, D. C., July 30, 1877.

The following sections of the Revised Statutes of the United States embrace all the provisions of law in relation to the distribution of seeds by this department:

"SECTION 520. There shall be at the seat of government a Department of Agriculture, the general design and duties of which shall be to acquire and to diffuse among the people of the United States useful information on subjects connected with agriculture, in the most general and comprehensive sense of that word, and to procure, propagate, and distribute among the people *new and valuable* seeds and plants.

"SEC. 526. The Commissioner of Agriculture shall procure and preserve all information concerning agriculture which he can obtain by means of books and correspondence, and by practical and scientific experiments, accurate records of which experiments shall be kept in his office, by the collection of statistics, and by any other appropriate means within his power; he shall collect *new and valuable* seeds and plants; shall test, by cultivation, the value of such of them as may require such tests; shall propagate such as may be worthy of propagation, and shall distribute them among agriculturists.

"SEC. 527. The purchase and distribution of seeds by the Department of Agriculture *shall be confined* to such seeds as are *rare and uncommon* to the country, or such as can be made more profitable by frequent changes from one part of our own country to another; and the purchase or propagation and distribution of trees, plants, shrubs, vines, and cuttings shall be confined to such as are adapted to general cultivation, and to promote the general interests of horticulture and agriculture throughout the United States."

The Commissioner finds no authority in these provisions of law for the distribution of any other garden and field seeds than those which are "new and valuable." It is obvious that the decision as to what is new and valuable must depend mainly upon considerations of soil and climate. What may be well known and comparatively worthless in one section of the country may be new and valuable in another. What is absolutely new and untried will of course require the test of experience to prove its value and ascertain its adaptability to any given section. It is plain, also, that the law does not contemplate the purchase and dissemination of such seeds as may readily be procured at the many seed establishments of the country.

It will be the aim of the department, in this view of its duties, to distribute as widely as possible such new and valuable and improved varieties of seeds as may be adapted to general cultivation, or to different sections of the country, so as to meet the various demands of our wide-spread population, and conduce to the interests of agriculture throughout the country. This distribution will be made through agricultural organizations and such individuals as may desire to enter upon a series of experiments, and who may seem to afford the best security for thorough, careful, and exhaustive trials of seeds in different parts of the country, and under varied circumstances of soil and climate. As the desired results of such a distribution can only be attained by repeated and careful experiments, the department will expect, as a condition of distribution, assurance of such a trial as will afford a satisfactory test. Blanks for making these returns will be sent with the seed, and when returned, carefully filled up, will entitle the person favored by the department to future consideration.

WM. G. LE DUC,
Commissioner of Agriculture.

So far as there has been opportunity to learn the public opinion, this circular has met with universal approval; and it is now hoped that by careful consideration of the condition of the soil and climate of different localities, and of the adaptability of seeds to each locality, a more beneficial and less wasteful dissemination of seeds will be made.

The *correspondence* of this department, both foreign and domestic, is increasingly valuable, in furnishing interesting and useful information as to the progress of husbandry at home and abroad. There is a continued and growing desire on part of the numerous governments of this continent, and other quarters of the world, with which a system of international agricultural exchanges has been established, to co-operate with the department, effecting a mutual interchange of agricultural and horticultural information, and of such seeds and plants as are indigenous to the respective countries; and among the farmers and planters of our own country there is an earnest spirit of inquiry as to the developments of agricultural industry, and the important interests which it is the object of the department to promote.

The following table exhibits, in a condensed form, the appropriations made by Congress for this department, the disbursements, and the balances covered into the Treasury, for the fiscal year ending June 30, 1877:

Title of appropriation.	Amount appropriated.	Amount disbursed.	Amount unexpended.
Salaries	$67, 836 96	$67, 806 19	$30 77
Collecting statistics	10, 000 00	10, 000 00	
Purchase and distribution of seeds	65, 000 00	62, 551 83	*2, 448 17
Experimental garden	5, 000 00	5, 000 00	
Museum and herbarium	2, 000 00	2, 000 00	
Furniture, cases, and repairs	2, 000 00	2, 000 00	
Library	1, 000 00	755 64	244 36
Laboratory	1, 300 00	1, 300 00	
Contingent expenses	10, 000 00	9, 998 97	1 03
Postage	4, 000 00	3, 462 37	537 63
Printing and binding	9, 000 00	9, 000 00	
Improvement of grounds	6, 550 00	6, 550 00	
Distribution of seeds in States ravaged by grasshoppers	20, 000 00	20, 000 00	
Total	203, 686 96	200, 425 00	3, 261 96

* Two thousand dollars of this balance to be paid as compensation for report on forestry, not yet presented.

It is shown by a recent statement made from the records of the Treasury Department that the total expenditures of the Department of Agriculture from 1839 to 1877, inclusive, amount to $3,366,114.37. From this amount should be deducted $100,000 appropriated in 1867 for the purpose of enabling the Commissioner of Agriculture to erect a department building, and the further sum of $50,000 appropriated for the printing of the annual reports of the department for the years 1872 and 1873, and erroneously charged to the current annual expenses of the department for those years. Deducting these two items from the above amount, and it leaves the sum of $3,216,114.37 as the aggregate amount appropriated during the existence of the government for the promotion of agriculture. The utter insignificance of this sum becomes apparent when compared with the amounts appropriated for the maintenance of other departments of the general government. Dividing the total amount appropriated by the number of years during which these appropriations have been made, and it gives the small sum of $84,634 as the average annual expenses of the department. When it is remembered that the last census established the fact that one-half the population of the United States is either directly engaged in agricultural pursuits, or is wholly dependent upon them for support, this sum becomes still more insignificant as an appropriation for fostering and promoting so vast an interest.

The following appropriations for the years named will be sufficient to illustrate the difference in the amounts appropriated for the various departments of the general government:

Departments, &c.	1877.	1878.
Department of State	$1, 188, 797 50	$1, 147, 660 48
Treasury Department	14, 837, 357 47	12, 784, 718 94
War Department	7, 337, 675 02	1, 983, 902 73
Military establishments	29, 651, 769 86	....
Navy Department	388, 598 24	365, 966 67
Naval establishments	12, 739, 790 90	14, 536, 432 90
Department of the Interior	3, 418, 432 89	3, 450, 627 14
Indian Affairs	5, 147, 897 63	4, 877, 990 00
Post-Office Department	567, 860 29	936, 549 20
Postal service	5, 917, 498 00	2, 939, 725 00
Department of Justice	385, 876 20	412, 622 05
Department of Agriculture	174, 686 96	208, 640 00

Under an act of Congress approved August 16, 1876, the Commissioner of Agriculture was directed to appoint some man of approved attainments, who was practically well acquainted with methods of statistical inquiry, and who had evinced an intimate acquaintance with questions relating to the national wants in regard to timber, to prosecute investigations and inquiries, with a view of ascertaining the annual amount of consumption, importation, and exportation of timber and other forest products; the probable supply for future wants; the means best adapted to their preservation and renewal; the influence of forests upon climate, and the means that have been successfully applied in foreign countries, or that may be deemed applicable in this country, for the preservation and restoration or planting of forests; and to report upon the same to the Commissioner of Agriculture, to be by him, in a separate report, transmitted to Congress.

Under this act my predecessor appointed Dr. Franklin B. Hough, of Lowville, N. Y. Since that appointment, Dr. Hough reports that he has diligently prosecuted these inquiries, and during the last summer traveled several thousand miles through the Western States and Territories, where the necessities of tree-culture are most severely felt, and in which a lively interest has been manifested in every question that has a bearing upon this vital interest. He has issued a series of circulars of inquiry, and has engaged in extensive correspondence both in this country and in Europe, receiving from the principal governments of the latter their most recent reports, and from leading foresters the latest results of experimental observation.

The report soon to be presented to Congress will give the results of these inquiries and experiments, and it is to be hoped will call the attention of our national representatives to the importance of the subject, and the necessity of encouraging and aiding a branch of agricultural industry so vital to the health and welfare of our people.

The need of a *general and complete index* to the thirty-seven volumes of the Annual Reports on Agriculture, embracing the reports of the Patent Office for 1838, and from 1841 to 1861 inclusive, and of this department from 1862 to 1876 inclusive, is constantly felt by all having occasion to refer to these records of our agricultural history, or who desire to profit by this store of experiences pertaining to that portion of our national development. In consequence of this want there has been for a considerable period in preparation an index of subjects, of 400 pages of manuscript, containing over 20,000 references, and also an index of scientific terms and of the names of the animals, birds, fishes, and insects, making an addition of 370 pages of manuscript.

These, if printed together, would make an octavo volume of 300 pages, or 200 pages if printed in double column. These are now complete, except for the volume of 1876, and this is in the course of preparation, and can be ready for the press with the general index before the other portions are put in type.

Which is respectfully submitted, by your obedient servant,

WM. G. LE DUC,
Commissioner of Agriculture.

THE CANE-SUGAR INDUSTRY.

(Special Report No. 1.)

Soon after induction into his present office, the attention of the Commissioner was directed to the condition of the sugar interest in the United States.

The facts elicited in this examination are thought to be of sufficient importance to warrant publication at this time, with the hope of awakening an interest in the subject commensurate with its great value to the whole country.

In view of the fact that the sugar-lands of Louisiana are unsurpassed in natural fertility and productiveness, and that in years preceding the war of the rebellion they furnished the country a very much larger proportion of its saccharine supply than since the conclusion of the strife, there is no satisfactory reason why the United States should continue to pay annually millions of dollars to foreign nations for articles of consumption that might readily be supplied by domestic producers. The production of sugar in Louisiana having fallen off immensely,* it was deemed advisable to obtain the views of planters upon the general subject, but more especially in relation to the particular causes of decline in the culture, and the best methods and appliances through the employment of which the industry might be restored, and, if practicable, still further advanced. The following letter was therefore addressed to leading planters of Louisiana:

DEPARTMENT OF AGRICULTURE,
Washington, July 28, 1877.

DEAR SIR: It is earnestly desired, so far as it is possible, by the aid of the department, to give encouragement to an increase in the production of sugar, that we may save the millions of dollars that annually go elsewhere for importations. We have a soil and climate adapted to the growth of cane inferior to none, and should, in fact, if proper attention were given to this industry, supply the markets of the world with sugar.

Will you give your attention and valuable experience to this subject and advise me how this department can best promote this interest?

Very respectfully,

WM. G. LE DUC,
Commissioner.

The large number of replies received to this letter and the warm interest manifested in the subject by the writers give much satisfaction to the department, and it is believed that substantial good will follow from the stimulation of special inquiry among the planters themselves.

In this correspondence, as it relates to the decreased production of sugar in Louisiana and the possibilities of the reinvigoration of the industry, the ground is very fairly, if not thoroughly, traversed. The causes of lessened production are clearly stated, and the remedies, to some extent, foreshadowed. The writers being for the most part land proprietors and planters, some of them of large experience, their statements and sugges-

* Bouchereau institutes a comparison between the crop of 1861-'62 and that of 1876-'77, which shows the former to have been 459,410 hogsheads, or 528,321,500 pounds of sugar, and the latter 169,331 hogsheads, or 190,672,570 pounds.

tions may be considered reliable and entitled to respectful consideration, to the extent that these relate to an industry with which they must be supposed thoroughly and accurately familiar.

CONSUMPTION OF SUGAR IN THE UNITED STATES.

The following tables were compiled by the New York Shipping List from governmental and commercial reports, by adding to the imports of each year the amount left over from the previous year and deducting the surplus at the close. To this is added a reliable estimate of the amount of domestic sugar and molasses produced within the year, deducting the quantities exported. This process gives a close approximation to the actual consumption. These figures are republished, with indorsement, by Mr. L. Bouchereau, in his excellent reports on sugar production in Louisiana. The importation of sugar and molasses on the Pacific coast is not given by the above authority, and cannot be made out from the Treasury reports in calendar years, for the reason that these reports conform only to fiscal years. Local statisticians at San Francisco give the importations for three years, omitting fractions, as follows: 1874, 32,425 tons; 1875, 22,850 tons; 1876, 30,882 tons.

Consumption of sugar in the United States.

Years.	Total consumption.	Imported.	Domestic.
	Tons of 2,240 lbs.	*Tons of 2,240 lbs.*	*Tons of 2,240 lbs.*
1860	415, 281	296, 250	119, 031
1861	363, 819	241, 420	122, 399
1862	432, 411	241, 411	191, 000
1863	284, 308	231, 398	52, 910
1864	220, 660	192, 660	28, 000
1865	350, 809	345, 809	5, 000
1866	391, 678	383, 178	8, 500
1867	400, 568	378, 068	22, 500
1868	469, 533	446, 533	23, 000
1869	492, 899	447, 899	45, 000
1870	530, 692	483, 892	46, 800
1871	633, 314	553, 714	79, 600
1872	637, 373	567, 573	69, 800
1873	652, 025	592, 725	59, 300
1874	710, 369	661, 869	48, 500
1875	685, 352	621, 852	63, 500
1876	638, 369	561, 369	77, 000

The importations of cane-molasses, in the same years, are shown as follows:

Years.	Total consumption.	Imported.	Domestic.
	Gallons.	*Gallons.*	*Gallons.*
1860	47, 318, 877	28, 724, 205	18, 594, 672
1861	40, 191, 556	20, 383, 556	19, 808, 000
1862	62, 668, 400	25, 650, 400	37, 018, 000
1863	37, 569, 088	26, 569, 088	11, 000, 000
1864	32, 410, 325	28, 582, 325	3, 828, 000
1865	35, 185, 038	34, 335, 038	850, 000
1866	45, 140, 110	43, 840, 110	1, 300, 000
1867	49, 776, 465	46, 776, 465	3, 000, 000
1868	55, 957, 969	52, 587, 969	3, 370, 000
1869	54, 361, 092	47, 961, 092	6, 400, 000
1870	49, 323, 171	42, 723, 171	6, 600, 000
1871	52, 065, 784	41, 165, 784	10, 900, 000
1872	53, 695, 203	42, 995, 203	10, 700, 000
1873	51, 485, 526	41, 985, 526	9, 500, 000
1874	48, 206, 257	39, 506, 257	8, 700, 000
1875	58, 608, 734	46, 418, 734	12, 190, 000
1876	48, 809, 504	36, 456, 504	12, 350, 000

From which tables it appears that, in the years named, the United States produced less than 13 per cent. of the cane-sugar it consumed, and little more than 21 per cent. of its molasses consumed.

The leading sources of our foreign supply are exhibited below. Twenty-one other nations supply the remainder, which is about 3 per cent. of the whole amount:

Countries.	Quantity.	Value.
	Pounds.	
Cuba	1,008,413,671	$41,039,048
Spanish possessions	110,445,708	3,572,400
Porto Rico	70,155,045	2,610,418
French West Indies and Guiana	49,687,265	1,751,478
Brazil	40,010,416	1,329,938
Dutch East Indies	26,187,830	1,052,953
British West Indies and Honduras	23,212,168	844,144
British Guiana	21,865,691	912,101
Sandwich Islands	20,978,374	1,051,987

Consumption per capita.—As the foregoing tables do not include the Pacific States, their population is deducted in obtaining the consumption *per capita*. The increase of population in the States east of the Rocky Mountains, during the ten years from 1860 to 1870, was at the rate of 21 per cent. for the whole decade, or over 2 per cent. per annum compounded.

Equalizing this increase, and allowing for the destructive influence of the years of warfare, the following rates of consumption *per capita* are arrived at, viz: 1860, 29.58 pounds; 1861, 26.14; 1862, 30.73; 1863, 20.05; 1864, 15.37; 1865, 24.08; 1866, 26.35; 1867, 26.17; 1868, 29.78; 1869, 30.35; 1870, 31.76.

The average increase of population per decade prior to the war was between 33 and 35 per cent., which would give nearly 3 per cent. per annum compounded. During the earlier years of the current decade, this rate was fully kept up by a very large foreign immigration. An increase of 3 per cent. is allowed for each year up to 1874, and 2½ per cent. for 1875 and 1876. This reduction is allowed on the ground of the falling off in foreign immigration. With the resulting figures of population as divisors, the estimates *per capita* of the current decade are as follows, viz: 1871, 36.80 pounds; 1872, 35.96; 1873, 35.71; 1874, 37.54; 1875, 35.39; 1876, 32.

With various fluctuations, the above figures show a steady increase in the consumption *per capita* up to 1874, the year in which our present commercial stringency was inaugurated. Each of the two subsequent years shows a marked reduction in the consumption, resulting from the decreased purchasing-power of the people.

The marked decline in consumption *per capita* during the late civil war is due, first, to the destruction of home production. Prior to the occupation of Louisiana by the Union armies, sugar-planters made great efforts to supply the Southern States, but the operations of war gradually restricted and the emancipation of the slaves finally prostrated this home production. Secondly, the blockade of Southern ports cut off the Southern people from the foreign market and prevented the import of supplies. Consumption was measurably restricted to the loyal States, but as the Union armies advanced a wider scope of trade was given and the aggregate imports enlarged. The close of the war showed a sharp advance from 15.37 pounds *per capita* in 1864 to 24.08 pounds in 1865.

The annual production of sugar and molasses in Louisiana from 1868 to 1876 is shown in the following exhibit. In the former year the industry began to recover from the prostrating effects of the civil war:

Year.	Pounds of sugar produced.			Molasses produced.	
	Brown sugar by old process.	Refined and clarified by vacuum-pans.	Total.	Total gallons.	Gallons per each hogshead of sugar.
1868	81, 506, 093	13, 545, 132	95, 051, 225	6, 081, 907	72
1869	....	....	99, 452, 946	5, 724, 236	65
1870	147, 562, 588	21, 346, 004	168, 878, 592	10, 281, 419	71
1871	126, 649, 952	20, 256, 173	146, 906, 125	10, 019, 958	78
1872	108, 501, 004	16, 845, 489	125, 346, 493	8, 898, 640	82
1873	88, 058, 278	15, 182, 841	103, 241, 119	8, 203, 944	92
1874	110, 856, 363	23, 648, 328	134, 504, 691	11, 516, 828	98
1875	131, 700, 360	31, 717, 710	163, 418, 070	10, 870, 546	75
1876	149, 904, 430	40, 768, 140	190, 672, 570	12, 024, 108	71

Referring now to the reports of the United States Bureau of Statistics, and confining attention to the last three years, we are enabled to present the custom-house exhibits of importations, together with the values thereof:

FISCAL YEAR OF 1874.

Sugar, brown	pounds	1, 594, 306, 354	$77, 459, 968
Sugar, refined	do	39, 259	3, 139
Molasses	gallons	47, 189, 837	10, 947, 824
Melada, sirup, &c	pounds	106, 952, 236	4, 424, 356
Candy, &c	do	56, 443	13, 916
Total		....	92, 849, 203

FISCAL YEAR OF 1875.

Sugar, brown	pounds	1, 695, 726, 353	$70, 015, 757
Sugar, refined	do	15, 251	1, 202
Molasses	gallons	49, 112, 255	11, 685, 224
Melada, &c	pounds	101, 768, 386	3, 313, 597
Candy, &c	do	76, 816	16, 737
Total		....	85, 033, 517

FISCAL YEAR OF 1876.

Sugar, brown	pounds	1, 414, 254, 663	$55, 702, 903
Sugar, refined	do	19, 931	1, 685
Molasses	gallons	39, 026, 200	8, 157, 470
Melada, &c	pounds	79, 702, 878	2, 415, 995
Candy, &c	do	87, 995	18, 500
Total		....	66, 296, 553

From which the fact is derived that the average annual value of imported sugar and molasses for the last three years is $81,393,091.

The large reduction in consumption in 1876, as compared with the three years immediately preceding, is attributable to the economy practiced by the masses on account of the stringency of the times, and the fact that there was an estimated falling off of about 200,000 tons in the sugar-producing countries from the crop of the preceding year, which caused an average advance of about half a cent per pound in the selling price.

The totals above presented do not, of course, represent the sums that have actually passed into foreign hands for our foreign supply, since, say, two-thirds is returned to the Treasury of the United States as duties.* Nevertheless, even at the present prices of cane-products, the amount that is so exchanged is enormous, and challenges the earnest and immediate attention of those who are anxious to promote our own industries. In view of the demonstrable fact that the capacity of the sugar-belt of the United States is sufficient not only fully to supply domestic needs, but also under proper stimulants to create a trade of export, it would seem gross unwisdom, if not, indeed, criminal neglect, to omit effort in the direction of fostering an interest of so great financial and economic importance. It is, moreover, a plain proposition that to profitably increase the production of one necessary commodity is to divert labor from the overproduction of another, thus adding to the general prosperity. Thus, we find through our correspondents that in most parts of the South the corn and rice fields, and even some of the cotton-areas, are not so remunerative as formerly. Diversity of crops is the requirement, both on account of the soil and the profitable employment of capital and labor. There is no fault found by sugar-planters with the prices received for their products. The profits are indeed extraordinary, even with the scarcity of labor and the unmethodical and crude methods of cultivation and cane manipulation taken into consideration. The immense loss entailed by the unscientific handling of the *bagasse* is referred to in another part of this article. A large planter in Jefferson Parish, whose letter appears in the appendix, demonstrates that on his crop of the present season a profit of from 80 to 100 per cent, is reasonably to be expected on his outlay.

The importation of sugar and molasses is a necessity only because a sufficient supply is not raised at home, and is not, therefore, to be regarded as a trade directly competing with our own product.

THE SUGAR-LANDS.

The authorities describe the sugar-growing region of Louisiana as lying on both sides of the Mississippi River, from about sixty miles below New Orleans to about two hundred miles above, including the lands about many of the bayous, the banks of the Red River, embracing the parishes of Avoyelles and Rapides, and the level lands of Vermillion and Saint Martin; and yet, as was stated in the report of this department for 1873, after an investigation of the subject by its statistician, the average area annually cultivated in sugar-cane in Louisiana did not exceed 150,000 acres, or about half of an ordinary county.† It was at the same time asserted that "if even this small acreage could be brought up to the standard which Mr. Bringier, one of the most intelligent planters in Louisiana, thinks is entirely practicable, the annual yield of the State would exceed 885,000,000 pounds of sugar and 52,500,000 gallons of mo-

* The report of the Bureau of Statistics for 1876 gives the amount of duties on importation of sugar, molasses, &c., at $42,000,000, in round numbers.

A New York commercial authority, referring to the magnitude of the sugar-trade, expresses the opinion that the value of the imported raw sugar sold, duty paid, in the United States the present year, will perhaps exceed $125,000,000, to which amount must be added the additional cost of refining, about $2,000,000. To this must also be added the value of molasses imported, from $50,000,000 to $60,000,000.

† Bouchereau shows that in the season of 1876–'77 there were 104,944 acres of cane-ground, which yielded on an average 1,817 pounds of sugar and 114 gallons of molasses per acre.

lasses, which would equal one-half our annual import of sugar and exceed our import of molasses."

Nevertheless, the sugar limit is not confined to Louisiana. In ten other states cane, with ordinary cultivation and appliances, has been found to give fair returns, while the reports of yields in the gulf regions of Texas give promise of great future results. Much of Florida bordering the gulf coast is indisputably well adapted to profitable sugar-culture. It would be very difficult, if indeed at all practicable, to secure accurate reports of the cane-product outside of Louisiana, in which it is a leading staple carefully noted; but, relying upon the United States census for 1860 and 1870, the following is the exhibit of cane-products in the Southern States in the years 1859 and 1869:

States.	1859.		1869.	
	Sugar.	Molasses.	Sugar.	Molasses.
	Hhds.	*Galls.*	*Hhds.*	*Galls.*
North Carolina	38	12, 494	35	33, 888
South Carolina	198	....	1, 055	436, 882
Georgia	1, 167	546, 749	644	553, 192
Florida	1, 669	436, 357	952	344, 339
Alabama	175	85, 115	31	166, 009
Mississippi	506	10, 016	49	152, 164
Louisiana	221, 726	13, 439, 772	80, 706	4, 585, 150
Texas	5, 099	408, 358	2, 020	246, 062
Arkansas	....	....	92	72, 008
Missouri	402	22, 305	49	....
Tennessee	2	2, 830	1, 410	3, 623
Totals	230, 982	14, 963, 996	87, 043	6, 593, 323

Referring again to the sugar-lands of Louisiana, several of the correspondents of the department are very emphatic in expressing the conviction that the area of land adapted to the production of the sugar-cane in that State is sufficient to furnish the United States enough sugar for its whole consumption, if under proper cultivation. Unfortunately, the lands best adapted to the cultivation of sugar-cane are all more or less subject to overflow. While a very inconsiderable portion of the best lands have been put under cultivation, even a large part of these has been rendered unfit for use by the destruction of the levees. In this connection attention is called to the letter of Mr. Longue, of Saint Charles Parish, as a case in point. He relates that on his plantation, before the crevasse of Bonnet-Carré, his crop was ordinarily from 200,000 to 300,000 pounds, and the crops of seven of his neighbors aggregated about 2,600,000 pounds; but that all these lands, as also those of thousands of others, adapted to the cultivation of sugar-cane, remain uncultivated on account of annual inundations. Another planter states that although he owns three sugar-plantations, he is unable, for the same reason, to work them.

Messrs. A. Thompson & Co., sugar-merchants of New Orleans, describe the sugar-area as follows:

Taking the Mississippi River, from the parish of Pointe Coupée down to within a few miles of its mouth, both its banks are lined the whole length with sugar estates, unequaled for the richness and fertility of the soil, especially the parishes of Ascension, Saint James, Saint John the Baptist, and Saint Charles, and, below the city, the parish of Plaquemines, known before the war as the "Empire Parish," on account of the richness of its productions, and now the great rice and orange growing parish of the State. We have also the lands along the Bayou La Fourche, a rich, black, and exceedingly fertile soil, and showing this year, so far, the largest canes and most promising crops. We must especially report that portion of the country formed of the parishes of Saint Martin and Saint Mary's, along the Bayou Teche, and known as the Attakapas region. Many Northern and Western capitalists, charmed by the beauty of the country, the salubrity of its climate, and the fertility of its soil, have purchased large plantations, and are yearly turning out paying crops, some of them shipping direct to Northern markets. We have also to mention the sugar-producing regions on Red River, composed of the parishes of Rapides and Avoyelles, where the culture is increasing every year, producing a good sugar and a rich, thick molasses, reddish in color, and unequaled for the grocer's trade.

Mr. F. L. Claiborne, of Pointe Coupée Parish, is of the opinion that there is cane-land enough in the State to make one and a half million hogsheads, if the levees are built up; and Mr. Joseph Anger, of Iberville Parish, a planter of forty years' experience, believes that the producing capacity of the State might be increased 300 per cent. by a proper system of levees.

Lands within the sugar-range are cheap and abundant. It is stated by competent authority that sugar-lands, on the navigable rivers and bayous, may be purchased at from $15 to $20 per acre, while they have a capacity for the production of 2,000 to 4,000 and even 5,000 pounds of sugar, with a proportionate turnout of molasses.

In the appendix will be found a table, collated from the ninth decennial census of the United States, showing the number of acres improved and unimproved in the sugar-parishes of Louisiana in 1869, which shows that in that year there were 748,539 acres of unimproved land, besides woodlands, in the State.

THE CROP IN LOUISIANA.

The sugar-product of Louisiana annually, since 1823, is tabulated as follows:

Years.	Hogsheads.	Years.	Hogsheads.	Years.	Hogsheads.
1823	30,000	1842	140,000	1859	221,840
1824	32,000	1843	100,000	1860	228,753
1825	30,000	1844	200,000	1861	459,410
1826	45,000	1845	186,000	1863	76,801
1827	71,000	1846	140,000	1864	10,387
1828	88,000	1847	240,000	1865	18,070
1829	48,000	1848	220,000	1866	41,000
1832	70,000	1849	247,923	1867	37,647
1833	75,000	1850	211,201	1868	84,256
1834	100,000	1851	236,547	1869	87,090
1835	30,000	1852	321,934	1870	144,881
1836	70,000	1853	449,324	1871	128,461
1837	65,000	1854	346,635	1872	108,520
1838	70,000	1855	231,427	1873	89,498
1839	115,000	1856	73,296	1874	116,867
1840	87,000	1857	279,697	1875	144,146
1841	90,000	1858	362,296	1876	169,331

Yet the methods employed have been of such a character that there may be said to have been a minimum of production, considering what might have been done with good culture and thoroughly scientific manipulation of the cane. While Louisiana gives 1,200 to 1,800 pounds of sugar to the acre (taking the last three seasons as the standard), the West India product is given at 3,000 to 5,000 pounds, and that of the East Indies often runs up to 7,000. It is stated on authority that in the Mauritius the product was at one time increased from 2,500 to 6,000 and 7,000 pounds. But this was by reason of very careful cultivation and the employment of the best means in the extraction of the saccharine matter. Porter, in his work on the sugar-cane (1843), states, concerning Mauritius, that the average production of sugar to the acre, from cane introduced from Java, was 2,000 pounds. In virgin soil of the best quality more than 5,000 pounds per acre were obtained; but this product was materially lessened the second year, and when the land had been cropped for several years in succession the quantity was frequently reduced to 1,100 or 1,200 pounds.

The matter of lessened yield, or of what is called by planters themselves "deterioration," is one of great moment in considering the question of sugar production. An American authority, writing on this subject before the war, refers to the fact that, "from some cause not well understood, the product of sugar to the acre is not so great as it has been in past years. This may be owing to continued repetition of the same crop without adding manures to the land, or to the practice of reserving inferior canes for seed; while some have supposed it is caused by deterioration of the stock through continued use of cuttings from the same source. To remedy the trouble, in case of this being the cause of deterioration, the United States Government recently [in 1856] collected a new supply of canes from the northern part of South America and distributed them among the planters."*

In his annual Louisiana sugar report for 1876–'77, Boucherau states that cane once planted in Louisiana remains in the ground from three to four years, furnishing from two to three successive crops, and that often the old stubbles are rooted up and the same land replanted in cane. Commenting on this management, he says:

A contribution so vital exacted from the soil tends greatly to impoverish it; yet this has long been an error in practice, and, what is worse, has been followed by planting in lands so impoverished the short-jointed and hard, woody stubble. It is this that has caused the present deterioration in cane.

He then cites the fact that unsuitable mineral fertilizers are employed, which, while producing an appearance of fertility, in reality impoverish the land, and still further contribute to the deterioration of the cane. When it is remembered that the sugar-crop is one of especial and peculiar exaction, and that under ordinary circumstances even the best soils need rest and replenishment of weakened or exhausted properties, the importance of an intelligent consideration of the best methods of restoring and sustaining our sugar-lands, and of staying the degeneration so generally complained of, will be at once apparent. On this point the observations of Mr. Moore, a planter of Washington Parish, in a letter to the department, are appropriate and suggestive. He says:

It is a well-known fact that, up to the time of the war, the cultivation of all Southern agricultural products was yet crude and undefined; but should the new appliances of drainage, deep plowing, fertilizing, and improvement in selection, which have enabled our farmers to quadruple yields per acre of their cotton and other products, be extended to the cultivation of the cane, at present prices of sugar, the value of our increased production would be almost fabulous.

So fully impressed is our correspondent, Mr. Von Phul (whose comprehensive letter is printed in full in the appendix), with the loss entailed by loose methods of cultivation, that he strongly recommends the establishment of an experiment station or farm, in order that the sugar-interest may be advanced by proper tests and the solution of a number of perplexing problems in cane-farming. Mr. Von Phul very justly relieves the planter of blame in the matter, giving, undoubtedly, the correct rea-

* In 1843 Congress ordered scientific investigations to be made relative to the chemical nature of saccharine substances and the art of manufacturing sugar, under the direction of Prof. A. D. Bache. The investigations were conducted by Prof. R. S. McCulloh, a chemist of reputation, and were thorough in their character, resulting in incalculable practical good to the planters of that day. A series of three reports, covering the chemical examinations, was published at intervals by the Secretary of the Treasury, the last making its appearance in 1847.

son, the great risk and expense attending pure experimentation. The letter here referred to affords an accurate picture of primitive methods still adhered to for the lack of thorough instruction in better, and, in the end, very much cheaper.

THE BAGASSE.

At the expense of repeating what has already appeared in the published volumes of the department, the following, from the Annual Report of 1873, condensed from a statement by Mr. M. S. Bringier, is incorporated in this inquiry, in order to show the possible profits that have failed to be realized in prosecuting the sugar industry:

The annual average yield of cane on the sugar plantations should be about 60,000 pounds per acre, containing 90 per cent., or 54,000 pounds of juice. The latter, at 80° 5′ Baumé, its average strength, contains 15.3 per cent. of pure dry sugar, making the average total amount of saccharine matter in an acre of cane 8,262 pounds, or one pound of sugar to about 7.26 pounds of cane. The sugar, on evaporation, absorbs water of crystallization, raising the percentage of sugar and molasses to 17.59, in the proportion of three parts of sugar to two of molasses. If there were a perfectly exhaustive process by which the whole saccharine element could be extracted, the average yield of an acre of cane would be about 5,700 pounds of sugar and 3,800 pounds of molasses; but the planters require from 35 to 55 pounds of cane to make a pound of sugar and two-thirds of a pound of molasses. The average of the State is 2.25 pounds of sugar and 1.5 pounds of molasses to each 100 pounds of cane. At this rate of production, an average plantation, with 100 acres under cultivation in cane, yields 135,000 pounds of sugar, at 8 cents per pound, and 90,000 pounds of molasses, at 4 cents per pound; total, $14,400. The expenses of culture are $5,000; of manufacture, $5,400; taxes, overseer, engineer, &c., $2,000; total, $12,400, leaving a net profit of but $2,000. Mr. Bringier thinks it demonstrated that 10.5 pounds of cane will easily yield a pound of sugar and two-thirds of a pound of molasses. At this rate 100 acres of cane, averaging 60,000 pounds per acre, should yield 571,428 pounds of sugar, at 8 cents per pound, and 380.952 pounds of molasses, at 4 cents per pound; total, $60,951.32. The expenses of cultivation and management would be the same as for the actual crop but the cost of manufacture would be enhanced, making the total expense $18,951.32, and leaving a net profit of $42,000, or $40,000 more than is now derived from 100 acres of cane on an average.* These considerations give some idea of the enormous losses inflicted upon the sugar interest and upon the country by unthrifty methods of production. It is a startling thought that probably a hundred million pounds of sugar are annually burned up in the *bagasse* of imperfectly-treated canes.

Mr. Von Phul refers to several processes, more or less successful, for the amelioration of the difficulty here described. But a change for the better appears to be promised, if the statements of Mr. A. De La Cornilliere, in his lately-published work on the "Culture of Sugar-Cane and Sugar Manufacture in Louisiana," be well founded, and the hopes entertained concerning a new method of handling the *bagasse* do not prove illusive. In referring to a recent invention of Mr. M. S. Bringier for the exhaustion of *bagasse*, he says that the apparatus is simple in execution and easily managed, and makes the *bagasse* yield 40 per cent., or 24 pounds, more juice than is furnished by the passage of the cane through the mill alone. "It is a well-known fact," he says, "that the cane, after several pressures, even as many as eight or ten, still yields juice, and that a complete exhaustion can only be obtained by dissolving the saccharine substances inclosed in the cellular tissues." Commenting on the statements of Mr. De La Cornilliere, the following observations are made by Mr. Bouchereau in his last annual sugar report:

The startling fact, so well attested, that 40 per cent. of the sugar-products of Louisiana, through all her great past, secured in the culture, have been lost through the inadequacy of the machinery employed in manufacture; that nearly one-half of the product has been cast away from countless thousands of fields of cane, extending back through so many years, indeed generations, is certainly calculated to arouse the interest not only of sugar-planters, but of society at large in all its classes and conditions, in the question of sugar production for the future, not here only, but everywhere.

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* See also letter of Mr. Bringier to the department, on the same subject, in appendix.

CENTRAL FACTORIES AND SMALL FARMS.

It is evident that if the area of sugar-planting be very widely extended in the adapted regions, including the sugar-belt of Louisiana, Texas, and Florida, there must be a wise innovation upon the old system of large plantations and expensive sugar-houses equipped by individual planters. There is land in great abundance, purchasable at rates very much lower than good farming-lands at the West. It is entirely practicable for these to be worked in small tracts by enterprising farmers, provided the central-factory system, now much talked about at the South, be set on foot. The great expense attending sugar-production, and the especial skill required, reside in the handling of the cane in the sugar-house. If capital erect sugar-factories in the cane districts, the profits of the small producer would accrue from the sale of his raw material. It is simply the carrying by the farmer of his wheat and corn to the miller or the commission merchant. How many small farmers might be expected to flourish at the North and West were it necessary to erect a grist-mill and a distillery on every farm? The system of cultivating small tracts would promote thrift and thorough work, and secure the best attainable results at the South in the cultivation of sugar, as it does at the North in the cultivation of corn and wheat. Such a division of labor would carry an intelligent and skilled element to the sugar-fields and infuse an energy into the industry hitherto unknown. It is satisfactory to note that the intelligent press of Louisiana is awake to this view of the case, and that attention is being particularly directed to the feasibility of the central-factory system and the great advantages to be derived from its practicable operation.

A few planters of Louisiana have already made efforts in the direction of practicing this method, which is found to work well in the French West Indies, and has encouraged many small farmers to raise crops and dispose of them for grinding. Messrs. Walker & Co., to whom allusion has been made before, are decidedly of the opinion that if this system were in vogue a great portion of the uncultivated lands of the State might be farmed out and cultivated in small tracts. They state the single objection that in Louisiana the grinding must be gotten through in the shortest time to avoid frosts, and the country is yet too sparsely populated to furnish enough material for new mills to be worked with success; "however, some of the larger planters are beginning to try the system of buying canes outside of their own crops and grinding them on their mill." But this difficulty, as well as the one of remoteness from fuel, may be overcome. The plan is being discussed of building cheap wooden, horse, or even steam, railways to timber-lands and water-courses from the interior prairie sugar-lands, thence to centrally-located sugar-houses. It is proposed that these roads be built by the united labor and capital of those immediately concerned, affording easy means of transporting both fuel and canes to the mill. "Our prairie-lands," says the Louisiana Sugar Bowl, published in the Attakapas region, "are all destined to be cultivated, principally in cane, as soon as railroads are built to supply the fuel, and we are confident that at least *two* lines from New Orleans to Texas will ere long pass over the prairies of Western Louisiana."

Mr. Walker, of Saint Mary's Parish, refers to the fact of such establishments being carried on where canes are purchased. The average price is $5 per ton of 2,000 pounds, weighed at the factory. In some cases land and seed-cane are furnished by the factory, when $4 per ton is paid for the canes. He states that the average product of an acre of plant-canes well cultivated, on fair land, is eighteen tons.

As will be seen in the appendix, several correspondents reflect a sentiment in regard to the encouragement of enterprising labor from the North, and a desire to change the "old plantation system," that promise the happiest results. Says Mr. Guion, of Assumption Parish, "We need more labor, and we can readily give employment to thousands of white men at remunerative rates, and whom we expect shall become owners of the soil, since large plantations are being rapidly divided, there being no longer here the ambition to possess large quantities of land that are unproductive." Mr. Moore, of Washington Parish, relates that experience at the South since the war has "thoroughly exploded the old theory that sugar could only successfully and profitably be cultivated by slave labor; also, the erroneous impression that good white labor could not be employed in this climate." And in this view he is very intelligently sustained by Mr. Spangenberg, of Jefferson Parish, to whose letter special attention is called. Mr. Austin, of Saint Mary's Parish, says that some effort has been made to introduce a white element there, and he is of the opinion that ultimately, "when the attention of our intelligent, industrious class of farmers is turned to this country, labor will be procured, and that of the right stamp."

SUMMARY.

From the foregoing the following facts are deduced:

1. That the United States is paying annually to other nations immense sums of money for a staple article of consumption which, the proper encouragement and support being afforded, might be produced at home.

2. That the production of sugar in Louisiana, our chief source of domestic supply, was about 63 per cent. less in 1876–'77 than in 1861–'62, while at the same time in the years of largest production a very insignificant part of the whole body of cane-bearing lands have at any time been under cultivation.

3. That the system of sugar-production heretofore followed has not been of a character calculated to produce the best results, great losses having been entailed on account both of the agricultural methods and the mechanical appliances used in extracting the saccharine matter, the loss through unscientific handling of the *bagasse* alone amounting to at least 40 per cent.

4. That an improved system of labor, involving the division and the cultivation of smaller tracts by individual owners, and a more thorough and scientific handling of the cane, would very largely increase the sugar-product and go far toward keeping pace with the annually-increasing demand of the whole country.

5. That successive plantings of the same seed-cane have resulted in a deterioration of the stock that demands serious and immediate attention.

6. That there are immense tracts of unoccupied and abandoned sugar-lands in Louisiana which are purchasable at low rates.

7. That the absorption of these lands by small cultivators depends upon the protection afforded by a good levee system, the establishment of central factories, and the construction of transportation ways.

8. That a very large area, heretofore highly productive, cannot be safely worked on account of inundations arising from the bad condition of levees.

9. That the new system of ownership of small farms, which is now being encouraged, will give growth to individual independence, draw around itself educational and refining influences, and build up and energize new and thriving communities, such as exist wherever self-reliant and intelligent labor flourishes.

The suggestions and recommendations of sugar-cultivators from whom letters have been received by the department are succinctly given as follows:

1. Protection of the lands from overflow by means of a levee system to be devised and maintained by the general government.

2. The clearing up and draining of swamp and low lands, and the determination of outlet drainage, with special reference to encouraging and assisting small planters, the system obtaining in Holland, or a suitable modification of it, being recommended.

3. Labor, white and colored, of which there is scarcity upon the lands even now worked. An element is desired that is willing to work on the tenant system, thrifty, ambitious to own lands.

4. Capital, to improve and clear up lands and "set things to rights," to erect and thoroughly equip sugar-houses, build tramways and lines of communication by means of which lands remote from water-courses may be carved into farms, and to introduce the most approved agricultural and manufacturing appliances.

5. Improvement of cane-seed through importations from other latitudes, to be distributed among the planters of the State.

6. In view of the great importance of securing a maximum amount of juice from the cane and the most desirable methods of manipulating it after expression, in order to produce a superior article of commerce, the appointment of practical chemists to study the operations of manufacture on the ground. These also to analyze the soils, provide means for converting the "trash cane" into a fertilizer, and to suggest such other fertilizing means as may best conduce to the re-establishment of weakened or exhausted soils.

7. The establishment of an agricultural college on the general plan of those at the North.

8. The establishment, by State aid or otherwise, of an agricultural station or experimental farm, for determining questions bearing upon the sugar-industry, since experimental tests conducted by individuals lack thoroughness, on account of the expense and time required to carry them forward to complete and reliable results.

APPENDIX.

EPITOME OF LETTERS FROM SUGAR-PLANTERS OF LOUISIANA.

JOHN D. MURRELL, Iberville Parish:

The national government should take our levees in hand and protect us from the disastrous annual overflows. It should also give us protection by placing a uniform tax of 2½ or 3 cents per pound upon *all* grades of unclarified sugars, and from 4 to 4½ cents upon clarified sugars imported. Immigration should be encouraged. Laborers are our great necessity; and with plenty of them, and the proper protection, the sugar-crop of this State would soon swell into hundreds of thousands of hogsheads annually.

CHARLES H. WALKER, of Walker & Thompson, Franklin, Saint Mary's Parish:

The lands best adapted to the cultivation of sugar-cane are all more or less subject to the annual overflow of the Mississippi, and their protection by the national government is imperatively necessary. * * * We want to improve our seed-cane; the loss by spoiling is annually on the increase, showing that it is deteriorating. We need fresh importations from other countries, to be distributed in small parcels to the planters. * * * We need more laborers. In the Teche country we pay from $15 to $25 per month for men, and provide them house, garden, fire-wood, rations, half an acre of land in field, and team and half of Saturday to work the same. We pay from 50 to 75 cents per day for women, without rations. During sugar-making we pay $1 per day and 50 cents for one-half the night. There are more wanted than are in the country. If the department could spread this information among the freedmen in other localities where there is a surplus and where they cannot get remunerative wages, or if they could be assisted in emigrating from such places, it would benefit the freedmen and the country. * * * Central sugar-factories are being established, where canes are purchased. The average price is $5 per ton of 2,000 pounds, weighed at the factory. In some cases land and seed-cane are furnished by the factory, and $4 per ton paid for canes. The average product of an acre of plant-canes, well cultivated, on fair land, is eighteen tons. * * * We need a more thorough knowledge of the chemical constituents of our various soils and the requisite fertilizers to increase the product of sugar.

HENRY WARE, Iberville Parish:

The soil in this section of the country, for richness and durability, is not excelled by any lands in the world, a large quantity of which is now uncultivated, and a large part of that so badly as to produce but little over half crops. * * * We need more capital and labor. If the large capitalists of the North and West could understand fully the large income to be realized from proper cultivation of these lands in sugar-cane, they would supply the needed capital. Labor would follow in abundance from different parts of the South, where both colored and white laborers are eking out a poor living on run-down lands in cotton and corn. * * * We need a good levee system in the hands of the general government.

E. W. MOORE, Washington Parish:

Only a small proportion of the best sugar-lands of Louisiana have been put under cultivation, and a considerable part of these have since been rendered unfit for use by the destruction of our levees during the war, we being unable to restore or keep them up. Could the Federal Government be induced to extend to us, in our present ruined condition, any assistance, not only in rebuilding our levees, but also in establishing a proper and thorough levee system, these abandoned acres would again be restored to the production of sugar, and there would be redemption of a body of alluvial land equal in extent to one-third the area of the whole State, superior in fertility to any other equal body of land in the Union, unexcelled by any in the world. * * * It is a well-known fact that up to the time of the war the cultivation of all Southern agricultural products was yet crude and undefined; but should the new appliances of drainage, deep plowing, fertilizing, and improvement in selection, which have enabled our farmers to quadruple yields per acre of their cotton and other products, be extended to the cultivation of the cane, at present prices of sugar the value of our increased production would be almost fabulous. * * * The cost of the levee improvements would be trifling, compared to the immense benefits to be derived not only by ourselves but by the whole country indirectly, to say nothing of the moral influence in healing past dissensions. * * *

The labor question.—Our experience since the war has thoroughly exploded the old theory that sugar could be successfully and profitably cultivated by slave labor only; also the erroneous impression that good white labor could not be employed in this warm climate. Under this theory, it would be difficult to explain the prosperity of highly productive countries in some parts of the world inhabited almost if not exclusively by the white race, situated much nearer the equator, and, consequently, in much warmer latitudes. My own experience, extending back to my earliest recollection, is that we have always had good white labor. The western and southwestern sections of this State have always been, with few exceptions, almost exclusively inhabited by the white race, among whom are many choice white laborers. * * * Owing to the heavy labor required in the cultivation and manufacture of sugar, as a matter of economy our experience has taught us the expediency of substituting machinery for manual labor wherever practicable. An advance in this direction before the war had made considerable progress. In this respect we not only led but placed ourselves far ahead of all sugar-producing countries, simplifying and cheapening all processes.

C. B. AUSTIN, Saint Mary's Parish:

The main question is how to obtain sufficient labor. In this respect we are deficient, and there is much diversity of opinion on the subject. Some advocate the introduction of Chinese; many send agents to the Carolinas, Georgia, and Virginia; but those negro laborers are generally inferior to our own as to work on a sugar-plantation. I only employ the Louisiana colored man. Some effort has been made to introduce a white element from the North and West, and I believe that ultimately, when the attention of our intelligent, industrious class of farmers is turned to this country, labor will be procured, and that of the right stamp.

JOHN B. PITTMAN, La Fourche Parish:

Encouragement of labor and capital is most needed to increase the production of sugar in Louisiana. There is abundance of land now lying idle, run to weeds. At present prices, sugar is the most profitable crop that can be raised. Many sugar-plantations for several years have been cultivated in rice, but the prices of rice are not sufficiently remunerative now. Reliable labor is scarce, even for the amount of cane now raised in the State.

L. G. ALDRICH, Assumption Parish:

I would suggest as follows: 1st. An importation of choice varieties of seed-cane to be placed in the hands of responsible parties who may take sufficient interest in the subject to devote their attention to acclimatizing them and obtaining the best results. 2d. A thorough and exhaustive analysis of the various fertilizers now being extensively used on cane, with a view to ascertaining which contain in most perfect form the elements essential in production of the component parts of cane and least destructive of the natural vitality of the soil, in order that we may be able to avoid the dangers which, to a certain extent, manifested themselves to the beet-growers of Europe, who, in order to obtain large results, fertilized to such an extent and with such material as to kill the land. In times past the fertilizer almost exclusively used was the pea-vine, which produced the result desired, partly by decomposition of the vine and in part by the dense shade it produced; but now there is yearly a largely increasing use of cotton-seed meal and other fertilizers, which, while they produce immediate grand results, will, in the opinion of many planters, work disaster to our land in the end.

NORBERT LANGUE, Saint Charles Parish:

In order to extend the production of sugar, according to the desire of the department, it will be necessary to put in a condition of culture the lands that have been abandoned since the great crevasses which inundated a considerable portion of the soil of Louisiana. These lands, formerly covered by abundant crops of the sugar-cane, now present to the view a vast and melancholy expanse of ruins and swamps, in which the waters of the Mississippi seem permanently to rest. I will cite but one example of the ruin of these lands, that of the destruction of my own and of some of my immediate neighbors. On my place, before the crevasse of Bonnet Carré, my crop ordinarily was from 200,000 to 300,000 pounds. The crops of seven of my neighbors were in the aggregate about 2,600,000 pounds. All these lands, as also those of thousands of others, adapted to the culture of the sugar-cane, remain uncultivated, for the reason that every year they are inundated by the waters of the river. The State has not the means of reconstructing the levees and closing the openings through which the waters come to drown the lands.

LEWIS GUION, Assumption Parish:

There is yet lacking confidence in the stability of our levees, which has discouraged immigration and sugar-production, and has caused a large area of the richest portion of the alluvial land of Louisiana to grow up in weeds. Should the government build up the levees of our inland sea, which washes the shores of so many States, and which has begun to be considered a national work, there will be an immense revival of the sugar-interest. * * * We need more labor, and we can readily give employment to thousands of white men at remunerative rates, and whom we expect shall become owners of the soil, since large plantations are being rapidly divided, there being no longer here the ambition to possess large quantities of land that are unproductive. * * * The department can do a great deal of good by sending a practical chemist to Louisiana about the 1st of October, to spend a winter in observing the modes of making sugar, the fertilizers employed and their effects, in analyzing the various soils, and especially suggesting some cheap and practicable mode of quickly converting the large mass of *bagasse* into a fertilizer, either by machinery, cutting it up into small particles after passing through the rollers, or by composting with some substance which would quickly decompose it at small expense. I believe it is entirely practicable to begin the use of tile-draining. If the department would try the experiment on a small scale on some sugar-plantation, I am satisfied the yield of sugar would be largely increased.

DANIEL THOMPSON, Bayou Teche:

Our seed-cane is undoubtedly very much deteriorated, as very little, if any, has been imported since 1861. If Congress can be induced to aid in the importation of some fresh seed, it will be of very great benefit to our planters. * * * It may not be out of place here to state some of the influences which, I think, militate against a large production of sugar in Louisiana. It is a fact that the lowest lands that can be cultivated in cane in Louisiana are much the most productive. There are immense tracts of these productive lands, that were in cultivation before the war, that are now lying idle, in consequence of the inability of the State to rebuild and keep in repair the levees on the banks of the Mississippi River. Even if this could be done in Louisiana, it would not avail much till the levees on the Mississippi are rebuilt in the States of Arkansas and Mississippi. Another of our misfortunes is that larger quantities of foreign sugar finds its way into our market without paying full, if any, duties. * * * In addition to fresh seed, I think the next greatest good to planters might be realized by the establishment in Louisiana of a State agricultural college, and the employment of a practical sugar-chemist to analyze our soils and the fertilizers we use, and to aid us with information regarding the manufacture of our sugar.

R. F. SPANGENBERG, Jefferson Parish:

The first thing necessary to be done to increase the production of sugar is to secure all the cultivable lands from overflow. The levees should be taken care of by the government. This one important step alone would insure immigration and capital. * * * It would be well to employ Northern white labor on the levees, on the railroads (say Southern Pacific), and the canaling, formerly done by Irish and German; also on the steamboats that ply on the Mississippi. This would give the sugar-planter the benefit of the labor of the negro on the plantations, where he is so well fitted for the duties of gang-labor. In harvest-time, when extra labor is required, the Northern white might be employed; and, little by little, he would learn something of sugar-planting, and finally be able to live on a plantation and make a crop on the share or tenant system—the only way in which to employ whites in sugar-culture, supposing them to be intelligent and thrifty, and ambitious themselves to be land-owners. This is the proper way in which to start new places and put new sugar-lands under cultivation. What is said concerning the whites not "standing the climate" is "all bosh." All the gardening for the New Orleans market is done around me on small places by white men, who work intelligently and take their *siesta* between 11 a. m. and 3 p. m., thus avoiding work in the heat of the day; in fact, I do the same *to save my mules*, to say nothing of the advantage to my negro laborers. Again, all heavy work is done by July, as then the sugar-crop is *laid by*. Having traveled seven years in Europe, I saw what white labor did there in the southern parts. This place includes 4,000 acres of land; 1,000 are in pasture, corn, and cane; say 340 in cane. Aiming at 1,000,000 pounds of sugar next year, I shall roll only 200 acres, reserving the 140 to make a large planting. With a fair season these 200 acres should give me at least 400,000 pounds of refined sugar (white and yellow clarified), worth, at present prices, including molasses, between $45,000 and $50,000; cost of making and staking off, $25,000 (including any permanent improvement); showing a profit of 80 to 100 per cent. on the outlay to make the crop. I have the most improved machinery invented, put up last year; sugar-house and machinery worth $50,000.

E. D. BARTON, Napoleonville, La.:

The most essential things for the promotion of sugar-culture in the State are, 1st, a good levee system; 2d, good drainage; 3d, increase of labor.

JOHN H. RANDOLPH, Iberville Parish:

Louisiana might make enough sugar for the whole United States if all our swamp-lands were cleared up and drained and substantial levees built on the Mississippi river.

F. S. BARBOUR, Plaquemines Parish:

Induce the government to take charge of the levees, and send us some of the surplus labor of the North to rebuild them and make them safe, then capital would come and labor would follow.

VINCENT BOGUE, Saint Landry Parish:

We want industrious white men, but men who will come to us with a sense of duty.

MARTIN GLYNN, West Baton Rouge Parish:

The only material aid the government can give toward increasing the production of sugar in Louisiana is to build levees. I expect to make 300 hogsheads of sugar this year. In three years I could increase the amount to 1,200 were I secure from overflow. * * * Some think a change of seed would be an advantage; but with security from overflow we can make large crops with the cane we have at present.

A. J. J. BARRIS, Terre Bonne Parish:

I am the proprietor of three plantations in this State, and am unable to cultivate any of the three on account of overflows; nor am I the only one so situated. There are thus thousands of pounds of sugar annually lost to our markets, thereby increasing our sugar importations and losing to the country millions of dollars. In my opinion the efficacious mode of avoiding this loss is for Congress to make some special appropriations for the building and protection of our levees, the government retaining control of them. This, I firmly believe, is the best and only way by which our sugar-interest can be promoted and our importations diminished.

F. L. CLAIBORNE, Point Coupee Parish:

The sugar-lands of Louisiana can be made to produce all the sugar that is required for consumption in the United States, and to spare. It is true the sugar-cane belongs to the tropics—it is an exotic here—but American skill, industry, and inventive ingenuity, and improved and improving modes of cultivation, will enable the Louisiana planter to make as much sugar as can be extracted from cane anywhere else. * * * A commission of three practical and intelligent planters should be sent to where the cane is indigenous to import selected seed for equal distribution among all the sugar-planters of the State. * * * There is cane-land enough in Louisiana to make one and a half million hogsheads of sugar, if the levees on the Mississippi are built up. Good and sufficient levees, capable of securing the Louisiana sugar-belt from overflow, can only be made through government aid. Let Congress aid us, and we will reclaim sugar-land enough to supply the United States and to export largely; thereby the cotton and sugar interests would be developed to so great an extent, that in three years the government, through increased imports, would be reimbursed three times over, and the internal trade and traffic between the States would be enormously increased.

W. H. BALLARD, Ascension Parish:

The government could render us great assistance if it would send to the State several practical chemists during sugar-making to watch the process and to devise means for destroying the coloring matter and for removing the vegetable impurities existing in the cane-juice. In order to give our sugar and sirup a good appearance, we use the fumes of sulphur to destroy the coloring matter, which, when combined with lime, that is used for removing other impurities in the juice, renders the sugar highly deliquescent, causing it to run off in the shape of molasses. This entails considerable loss. It is also desirable to devise means by which to check fermentation in the molasses. It is rarely the case that planters pretend to know anything about the handling of the juice in order to make good sugar. Through proper instructions furnished, the government could accomplish a great good, saving us from an immense loss in handling the juice, and increasing the production of sugar correspondingly. Besides this, and the importation of new varieties of cane, I do not know that the government could particularly serve us.

JOSEPH ANGER, Iberville Parish:

Sugar-culture in *ante-bellum* times was by far the most profitable crop the farmer could cultivate, and since the war it has proven even more so. I have been a practical sugar-planter for forty years on the Mississippi, and through many vicissitudes, without much loss. I find our methods of production and manipulation susceptible of great changes. As to the best method of promoting this great and growing interest, the first step must be taken by the government in the reclamation of the low lands, upon which, principally, sugar-cane is grown. The country especially adapted to sugar-culture is that portion of the alluvial region bordering on the Mississippi below Vicksburg. The present producing capacity of our State, by a proper system of national levees, can be increased 300 per cent. * * * Fifty years' experience in this State has demonstrated the utter futility of the State attempting to keep up its own levees. Legislation of a national character is necessary to a reclamation of the low lands. Suppose all the riparian and interior communities of this State were protected from the Mississippi south of the Arkansas line, the levees above being in bad condition; if a break occur, the water will come south through the Yazoo Valley on the one side and break through the Bayou Macon Hills from the Saint Francis Valley on the other, flanking the whole interior, and rendering a supposed good system south wholly a nullity. * * * With the fostering care of the government extended to our levees, local capital and increasing good labor will soon place our section in the foremost rank of sugar production. * * * Government might assist us in the way of importing tropical seed, as some of our cane has very much degenerated. * * * My lands readily yield me a net income of $60 per acre.

JOHN DYMOND, New Orleans:

I would suggest one thing that I think of grave importance, and that is the determination of some method of outlet-drainage by a combination of small proprietors. Thus far large estates have been the rule in Louisiana, and the outlet-drainage has been obtained by digging large canals long distances to lower levels, or by digging canals and elevating the water from the same and throwing it over and beyond the rear protection levees by means of large drainage-wheels, such as are used in Holland. I have just erected one of these wheels, which will throw out about 50,000 gallons of water per minute, and the wheel, engine, boilers, foundations, &c., and about ¾ mile of canal, 20 feet wide and 5 feet deep, have cost me $15,000 cash. It is this drainage matter that interferes with small proprietorships in Louisiana. In Holland they organize local drainage districts, calling them *Polders*; and they are duly surveyed, inclosed by levees, or dikes, as they are called, and duly drained by steam or wind wheels. This I understand to be done by commissioners elected by the proprietors, and managed perhaps as a bank or incorporated company, under the so-called *Polder* laws, the cost being assessed on all the land inclosed within the *Polder*. I own many thousand acres of land in Louisiana, and all that is under cultivation is drained five feet below the level of the land artificially, at an expense of less than $3 per acre per annum. Not one-quarter of this land would produce good crops without artificial drainage. Should I sell forty acres, the purchaser would at once have his drainage closed, or be compelled to make some *temporary* arrangement with me, and hence but a few such sales have been made; and I do not see how they can be in the best alluvial lands, which are all low, until this problem is solved. They have been solving it in Holland for five hundred years, and, I presume, have a full code of laws in relation to the matter. I think you can hardly do any greater service to the sugar industry, and particularly to the freedmen and small proprietors, than by obtaining these laws and translating them into English, and circulating the same in Louisiana.

CHARLES STARR, Saint Martin's Parish:

Louisiana should produce sugar enough for the whole nation; but one great drawback is the want of capital, as the most of the planters were ruined by the war, and the reported violence, &c., of the people have deterred Northern men from coming in. So far as I can judge (and I have had exceptionally good means for information), no Northern man who minds his business has had any difficulty. I am well known as a pronounced Republican, and openly voted for Hayes and Wheeler; and no one has given me the cold shoulder. It seems to me unfortunate that the treaty with the Sandwich Islands admits sugar free, for two reasons: First. I had been informed that the farmers of California were going largely into beets for sugar, it having been ascertained that the climate and soil of that State were exceptionally favorable for sugar-beets. As a result of the treaty that enterprise, I am informed, has been abandoned. Second. Although the area of land for sugar-cane in those islands is not very large, the area for fraud seems to be unlimited. No doubt attempts will be made on an immense scale to land cargoes of East India sugar there, refine it, and ship to the United States and elsewhere. It is true that the consuls and others may have instructions from the government to look closely after the matter, but the inducements for fraud will be enormous, and it will take a good deal of virtue to withstand them. In answer to the inquiry, "Why cannot sugar be raised in small quantities by the negroes and others, and small or portable mills and evaporators be used for manufacturing the same?" I reply that the best mills, with steam-power, do not get more than two-thirds of the saccharine matter from the cane, and the horse-mills very much less, and consequently they are very wasteful. Various plans have been adopted to supplement the mills run by steam, and some of them, apparently, have made considerable gain; and as a good deal of invention is enlisted in the enterprise, we may fairly look for considerable gain in the product of the cane. The true interest of the small farmers is a union for a good apparatus; or, where they are within reach of a steam-mill, &c., either to sell their cane or have it made up on shares. Around my plantation are many small planters, black and white, and they have had their crops made up at my sugar-house, and are increasing the production of cane and diminishing that of cotton. This is the true policy, and will largely add to the production of sugar.

Messrs. A. THOMPSON & Co., New Orleans:

We have tried to gather and place in the hands of the department all information in our power, in view to aid in furthering the interests of the production of sugar. The area of land adapted to the production of the sugar-cane is adequate to furnish the United States with enough sugar for their consumption if under proper cultivation. Taking the Mississippi river, from the parish of Pointe Coupée down to within a few miles from its mouth, both of its banks are lined the whole length with sugar-estates unequaled for the richness and fertility of the soil, especially the parishes of Ascension, Saint James, Saint John the Baptist, and Saint Charles, and below the city the parish of Plaquemines, known before the war as the Empire Parish for the richness of its productions, and now the great rice and orange growing parish of the State. We have also the lands along the Bayou La Fourche, a rich, black, and exceedingly fertile soil, and showing this year, so far, the largest canes and most promising crops. We must especially report that portion of the country formed of the parishes of Saint Martin and Saint Mary, along the Bayou Teche, and known as the Attakapas region. Many Northern and Western capitalists, charmed by the beauty of the country and the salubrity of its climate and fertility of its soil, have purchased large plantations, and are yearly turning out paying crops, some of them shipping direct to Northern markets. Among these planters a few have introduced the system used in the French

West India Islands of central sugar-mills, and are buying the cane grown in the neighborhood, thus enabling the small planter to raise a crop and sell it without expense of machinery for grinding, &c. If this system were more in vogue we have no doubt that a great portion of our uncultivated lands would be farmed out and cultivated by small planters, and add thereby greatly to the general prosperity.

There is one drawback, however. In the tropical countries the grinding is not interfered with by cold weather, while in Louisiana it has to be got through in the shortest time to avoid frosts, &c., and the country is yet too sparsely populated to furnish enough of material for these mills to be worked with success; but, however, some of the large planters are beginning to try this system of buying canes outside of their own crops and grinding them in their mill. We have also to mention the sugar-producing regions of Red River, composed of the parishes of Rapides and Avoyelles, where the culture is increasing every year, producing a good sugar and a rich, thick molasses, reddish in color, and unequaled for grocers' trade. We would recommend that your department publish in some pamphlet form statistics showing the advantages of sugar-producing districts in this State, and thereby insure immigration to a magnificent, fertile, and most healthy part of the United States. The yellow fever, which is sometimes brought to this city by vessels from Cuban or South American ports, seldom extends into the country; and New Orleans is this year, according to statistics, the healthiest city in the Union. We would also suggest that the department afford to sugar-planters all facilities of knowledge of improvements here and in foreign countries on boiling and making sugar, and especially experiments in manuring and fertilizing the land, &c., and that the government establish a chemical laboratory to analyze the different soils, and give information as to the proper fertilizers required to increase the growth of the cane. It could be established in the custom-house or other central government building in this city. This we consider one of our greatest needs. The government should, through its agents abroad, procure seeds of the different kinds of canes, and distribute the same among the planters, or sell it at a nominal price. Experiments could then be made to test the best kind adapted to the soil and climate. We have ourselves made experiments on the Bourbon and Java or ribbon-cane, and find that the latter has nearly doubled the yield per acre; *i. e.*, where we made 1,200 to 1,500 pounds of sugar to the acre before using the ribbon-cane, we have doubled the quantity since using it, and furnish our own experience, which we trust may be useful for the planters at large. The Otaheite cane was largely cultivated before the war, but has since degenerated. It is very sensitive to frost, and has been replaced by the Java and Bourbon on that account. Your attention is especially called to the above, as the want of good seed-canes is one of the most pressing of our planters, and we think that the government, with its numerous agents, is naturally the one whom they should look to in this matter. Many planters, as their means increase, are leaving the old system of open kettle and adopting the vacuum pans and centrifugals, thereby increasing the quantity and improving the quality of their products, and by the employment of an adequate number of mechanics to attend to this more intricate machinery, are adding to the general prosperity. The fears of crevasses or overflows have from year to year caused serious apprehensions among the planters on the Lower Mississippi. The Bonnet Carré crevasse (not yet closed) has ruined many a planter and brought desolation on several hitherto fertile and rich estates. In view of this, we strongly recommend that the general government take entire charge of the levees and place them under the control of officers of the United States Engineer Corps. We think the present system of determining the classification of sugars imported from foreign ports detrimental to Louisiana sugars, inducive to fraud, and not proper to fully ascertain the exact grade of the sugar, and would seriously recommend that the test be made by polarization as well as color, else we do not see how it is possible to arrive at anything like a correct or definite classification. One of our present utmost needs is labor, which is scarce and wanted. There are sugar-lands along the Gulf coast which are now lying in waste and unproductiveness, not only in our own State but also in Alabama, Florida, and Texas, and if labor could be had and the surplus population of Northern cities be made to understand the cultivation of these lands it would add greatly to the prosperity of the country at large. The colored laborers are working well, being promptly paid, and as a general rule all intercourse between the planters and their hands is as desirable as can be. We are ourselves owners of a large plantation below the city, employing quite a large number of hands, and find them happy and contented, never giving us the least trouble, and working well. In conclusion, we will say that we are pleased to see the government trying to promote and encourage what will be one of the largest agricultural products of the country, and we shall take pleasure in furnishing the department with all the information in our power concerning the coming crop, which so far promises well and will probably exceed the late one by about 5,000 to 10,000 hogsheads, with an average yield of molasses.

D. W. BRICKELL, New Orleans:

For half of October and all of November and December we want a large number of good workingmen to help take off our crop of cane. We want them for both indoor and outdoor work; and, to extend our operations, we shall want them afterward. * * * Beyond question, white immigration is necessary to the development of the country, as the development must take place on the system of small farming and central sugar-houses, the growth and the manufacture of sugar being separate industries. But immigrants who come here and go to work for wages with the large planters for one, two, or three years will be best off; as, while becoming used to the climate, they are learning all about cane cultivation and are laying up something to make a beginning themselves. * * * Although making sugar on a large scale is fairly profitable to the large planters, it is infinitely more so to the small ones, especially those who take their cane to another man's mill and keep their capital in the culture. The Western farmer knows no business so profitable. We of the South always knew that the white man could work here as well as the negro.

JOHN C. COFIELD, Ascension Parish:

An obstacle in the way of the production of sugar in this country is the expense of the machinery required in the re-establishment of the old plantations devastated by the war, and few persons are willing to incur such heavy expense without some assurance that the laws will be permanent and their investments secured against changes in the policy of the government. Many plantations, also, now cultivated in cotton, might be transformed into sugar-cane, and in a very few years enough sugar could be produced to supply the entire consumption of the United States. * * * Sugar-planting does not admit, unless in very favorable situations, of the raising or growing of our own supplies of provisions, and our food, machinery, &c., must be supplied chiefly by the Western and Northern States. On that account there is a reciprocity of home interests to be obtained by the enactment of permanent revenue-laws to encourage the production of sugar. The greater the number of plantations brought under culture, the greater demand will there be for provisions and machinery from the West and North.

SAMUEL CRAGIN, Terre Bonne Parish:

Anything the department can do to introduce a cheap and good fertilizer suitable to our soil and crop would greatly stimulate the sugar-industry.

J. M. HOWELL, La Fourche Parish:

Nine-tenths of the sugar-lands are subject to overflow; and as the growing of a sugar-crop requires the expenditure of a large amount of money, people are loath to engage in such enterprises on a large scale with the little protection they now have against the disasters of an overflow.

H. VON PHUL, East Baton Rouge:

The first matter for consideration, for it is vital in importance, is the immediate adoption of a new and important levee system—one that will be complete and satisfactory in all its details. You are doubtless aware that under the old *régime* the riparian proprietors were obliged to build and keep in repair their levees. Since the war, owing to our impoverished condition and the ravages entailed by the war, this system was found impracticable. The State resorted to a general levee-tax; but this system, owing to a bankrupt treasury, depreciated State bonds, and, I fear, dishonest State officials, has resulted most unfortunately, and was found to be futile. Our last legislature again threw the responsibility of maintaining our levees upon the riparian parishes; but this, for reasons given above, will be found impracticable.

The opinion is now general that, owing to the impoverished condition of the South, it will be impossible for her to build and maintain her levees without the aid of the general government; and as this important subject has been, and will again soon be, before Congress for consideration, I respectfully refer you to our petition for full particulars on this important subject, which I think cannot be regarded otherwise than as national. We therefore hope that the general government will either build and maintain the levees along the great highway or lend aid in so doing. This done, and minor subjects receiving due attention, the prosperity of the South and the sugar-interests of Louisiana would rest upon a solid foundation. Then, and then only, would be realized the most sanguine expectations. In short, with our climate, soil, and great natural advantages, there would be no estimating her capacity or the limit to her resources.

Second in importance to our levees I regard the immediate establishment, by State aid or otherwise, of an agricultural station or experimental farm. We live in an age of wonderful progress and general improvement, and it is important that agriculture should keep pace with this onward march. Individual experience is too slow for the times; particularly is this the case for a satisfactory and successful progress of the sugar-interest; but with the aid of an experimental farm important facts could soon be established, the benefits of which to the planters and States could never be fully estimated. Up to the present time few intelligent experiments have been made in the general cultivation of the sugar-cane. This is not, in my opinion, owing to a want of the proper disposition or want of intelligence on the part of the planters, but owing chiefly to the great expense and risk that such experiments entail.

With the aid of well-conducted experimental farms, the following information could in a few years, be given, the beneficial results of which would be incalculable:

1st. What is the best time, and what the best method, to plant cane?

2d. What is the best time, and what the best method, to secure seed-cane?

3d. What is the best method of securing rattoon and stubble cane?

4th. What is the best method of cultivating plant-cane?

5th. What is the best method of cultivating rattoon and stubble cane?

6th. What is the best method of cutting cane for the mill, with the view to the future preservation of the plant or stubble?

7th. Is not the practice, now in general use, of hilling cane detrimental, cutting cane-roots injurious, &c.?

8th. Is not flat cultivation of the cane in accordance with its natural growth, and hilling, as now practiced, injurious?

9th. What is the best method of rotating for cane-crops?

10th. Which is preferable, machine or hand-hoe for digging off stubble-cane?

11th. Which is preferable, machine, horse-hoe, or hand-hoe, for "laying by" plant-cane?

12th. What is the best fertilizer for cane?

13th. What is the best method of feeding a cane-carrier so as to obtain from the mill the best results?

14th. What process for extracting the cane-juice by the aid of the mills now in use is preferable?

15th. Can cane-juice be improved by settling in tanks or otherwise? If so, what is the best method, and how long should it stand?

16th. What is the market-value of sirups (density and polarization being given) as compared with sugars?

In my remarks regarding the cultivation of the cane and how best to extend the same, I shall not enter into details of the operation, which is familiar to most persons interested, but shall simply make mention of what I regard the errors of the present system, and will preface my remarks by observing that the genius of American agriculture is too superficial. We want better farming, less area of land; in short, we must cultivate better and do more of it than formerly. How this is to be accomplished is the question that must be solved satisfactorily before we can hope for a decided improvement or extension. All lands intended to receive plant-cane must be thoroughly broken by at least four mules, with the best improved plow, and in the fall, if possible. Deep plowing is indispensable, for upon it depends the successful use of the present highly-improved agricultural implements, now happily within reach of all that desire them, and by the aid of which we can readily pulverize the soil and keep it in the desired condition.

I am fully assured of the fact that no class of men are so "wedded to their idols" as the farmer and planter. "My father was a successful planter; he cultivated his fields thus and thus, using such a plow and hoe (that everlasting hoe); he made good crops. It is true that lands were fresher than now, but I respect his memory, and shall ever do as he did." This, I believe, is the argument of all the good old planters and farmers of the country. But, with all due respect to them and their inherited opinions, we must acknowledge that times have changed, and we might as well ignore the steam-car and return to the old stage-coach as adhere to that everlasting hoe and plow. It is a popular error to adhere to and rely exclusively upon the plow and hoe. The same results can be accomplished by the use of the present improved agricultural implements, and at much less cost.

To illustrate: one man, under favorable circumstances, will dig off the soil from, say, one acre of stubble-cane in one day. Now, with the aid of an improved stubble-digger (such as I have used for the past three years) one boy, seated on the machine, and two mules will accomplish the same amount of work in one hour; and, in my opinion, the machine-work is infinitely preferable. Again, one man can lay by (that is, give the cane the last working), say, one acre of cane; with the aid of an improved horse rotary-hoe this amount can be accomplished in thirty minutes, by the aid of two mules and one man, the operator riding and having a good easy time of it. I might continue my illustrations, but let the above suffice. What I wish to impress upon the planters of the South is this: too much reliance is placed upon the hand-hoe, and our fields in consequence are badly, if not too expensively, cultivated. Hand-hoeing is doubtless necessary for a foul drill, but only then; with middles kept in perfect order, that is deeply and thoroughly pulverized by the aid of an improved cultivator, all the necessary work can be accomplished by the aid of improved implements, thereby lessening the expense of cultivation.

In order to reduce our expenses of cultivation we must lessen the hand-hoe work This can be to a very great extent accomplished by increasing our team; for each plowman we should have at least three mules. A full team and the use of improved implements will enable the planter to pass over his crops once every week. With regard to the manufacturing of sugar from the cane-juice, too much praise cannot be given to the sugar-planters of Louisiana. They have, indeed, exhibited a high order of intelligence—spared no expense to perfect their machinery; and to-day Louisiana, with just pride, can point to her marvelous achievements. Her sugar will compare favorably with, if it is not superior to, any other made. But while the manufacturing of the cane-juice into sugar has been perfect, I cannot help thinking that our planters have sadly neglected other points connected with this branch of the business. I regret to say that there is yet a great want of diligence and proper exercise of judgment in the general management and use of the cane-mill. For the past two seasons I have had occasion to visit some of the largest and best-appointed sugar-houses in the State. These establishments were manufacturing beautiful sugar, the apparatus for manufacturing being faultless; yet I cannot but express the opinion that not one of those I visited was returning fair or satisfactory results. I found, as a general rule, mills running at too great speed, great negligence in feeding cane-carriers, the *bagasse* absorbing in its exit from the mill large quantities of juice. Few mills in the State are realizing for their owners over 60 to 65 per cent. of cane-juice. This loss can in a great measure be reduced by proper attention to the adjustment of the mill and great care in feeding the cane-carrier, so as to deliver the cane to the mill in a continuous and uniform quantity. Having given this subject close attention, I have found the best results by adjusting the mill to receive the canes from the carrier only one cane deep, but uniformly spread over the entire surface of the carrier. In this way the supply of canes enters the mill regularly, and if the supply is continuous the pressure exerted by the mill is uniformly exerted to its utmost capacity. Should the planter find that by such a feed he cannot keep a supply of juice sufficient for his daily necessities, he will find it greatly to his interest to dispose of his mill for one of greater capacity. It is a well-known fact that no mill has yet been devised that will extract all the cane-juice known to be contained in the cane, the best practicable results, as remarked above, being from 60 to 65 per cent.; but I believe that a large majority of the planters do not realize over 50 per cent. To meet this difficulty, we here present to the consideration of those interested several new processes:

1st. The Robert diffusion process, which, I regret to say, proved unsuccessful.

2d. The Mason process, which I believe possesses many advantages. In this process the inventor deals with the *bagasse* after it has left the first mill, and then saturates the *bagasse*, after which it is carried to a second mill and again subjected to a great pressure. By this process the inventor claims an increase of 15 to 20 per cent. of juice over the old process.

3d. The Mallon process. This process has been in operation for the past three years on Hollywood, and for simplicity and insignificant cost recommends itself to all interested in the sugar interest. The apparatus consists in placing a perforated steam-pipe in the cane-knife or return-plate, and applying steam direct from the boilers to the cane while passing through the mill. The inventor claims an increase of 20 per cent. over the old process; and the practical experiments at Hollywood demonstrate that 72 per cent. has been obtained from old stubble-cane and 74 per cent. from plant-cane. The cost of making this application to the mills as now used is about seventy-five dollars.

I believe that the cane-planting interest is fully alive to the importance of improving the lands by judicious fertilizing; yet the question of the best fertilizers for cane is not easily determined. Guano, stable-manure, cotton-seed, and cotton-seed meal, and other spent manures, will make all plants grow with luxuriance; but which is the best fertilizer for the formation of rich saccharine in the sugar-cane is a question yet open for further experiment. From all I can learn upon this subject, I am of the opinion that the formula of Mr. George Villé is the best; the component parts of which are phosphate of lime, nitrate of potash, and sulphate of lime in due proportions.

There is yet another subject well worthy of due consideration of both planters and capitalists, which is this: There are comparatively few planters who are provided with the present improved apparatus for manufacturing sugar. The large majority of planters, owing to pressing necessity, still adhere to the old and wasteful system of open kettles. In estimating the cost of manufacturing sugar upon the improved apparatus of the day, we find it to be very great, requiring an expenditure of not less than $20,000, an amount that would purchase a large and valuable sugar-estate. I am of opinion that, for this reason, if for no other, the manufacturing of sugar on most of the plantations should be greatly modified; in fact, I will go further, and state that, with the necessary capital and ordinary business competition of refineries located at New Orleans, it would be found more profitable to convert cane-juice into well-concentrated sirup and ship direct to market. The advantages of this system would be very great. First, the open kettles, the steam-trains, and the small evaporating-pans in use upon the majority of the plantations can make sirup equal in refining quality to that produced by the most approved apparatus, as it is only in the last stages of the operation of sugar-making that the sirup or sugar is damaged and inferior sugar made. By simplifying our present method of converting our cane-juice into sirup, say, to a density of 30° to 35° Beaumé, we would greatly lessen the expense of manufacturing; we would require less fuel, would dispense with skilled labor, with coolers, with long delay in potting and in the purging-room, and the great loss in waste and leakage in cisterns and elsewhere. Finally, but not least, we would save much time in taking off our crops, to say nothing of the fact that our produce would be ready for market a few hours after leaving the evaporators. The only objection I can see to the adoption of this system and its practical working is the want of a market for the sirup. If capitalists would erect refineries in New Orleans, and assure planters that they would pay fair prices for their produce in this shape, I cannot help thinking it would be mutually profitable. The sugar-planter would get the full value of his produce, and the refiner would have his stock in the best possible shape to be converted into any desired quality of sugar.

To extend our sugar-interests, we must lessen the cost not only of cultivation but also of the necessary apparatus for taking off our crops, and if this system were once established it would, in my opinion, give a great impetus to business, both to refiners and planters.

SUGAR PRODUCTION OF THE WORLD.

Bouchereau, in his Annual Sugar Report for 1876–'77, quotes from an eminent English authority the following tables showing the production of cane and beet-root sugar in 1875 in the producing countries of the world:

CROPS OF CANE-SUGAR, IN ROUND NUMBERS.

	Tons.		Tons.
Cuba	700,000	Louisiana	75,000
Porto Rico	80,000	Peru	50,000
British, Dutch, and Danish West Indies	250,000	Egypt	40,000
		Central America and Mexico	40,000
Java	200,000	Reunion	30,000
Brazil	170,000	British India and Penang	30,000
Manila	130,000	Honolulu	10,000
China	120,000	Natal	10,000
Mauritius	100,000	Australia	51,000
Martinique and Guadeloupe	100,000		
Total tons			2,140,000

BEET-ROOT SUGAR.

	Tons.		Tons.
German Empire	346,646	Austria and Hungary	153,922
France	462,259	Belgium	79,796
Russia and Poland	245,000	Holland and other countries	30,000
Total tons			1,317,623

The following extract is taken from "A Complete Treatise on the Fabrication and Refining of Beet-Sugar," by L. Walkoff, "proprietor and fabricator of sugar at Kalinowka, Podolia, and member of several learned societies." This work brings up its statistics only to 1872–'73.

SUGAR PRODUCTION IN DIFFERENT COUNTRIES IN 1872–'73.

Countries.	Number of factories.	Weight of sugar-beets.	Quantity of sugar produced.
		*Kilograms.**	*Kilograms.**
France	487		400,000,000
Germany	304	3,050,645,600	260,000,000
Russia	318	2,140,000,000	150,000,000 (Russia and Poland)
Poland			
Austria	220	2,135,000,000	205,000,000
Belgium	117		80,000,000
Holland	29		
Sweden	6	20,000,000 (Sweden, Italy, England, America)	†35,000,000 (Sweden, Italy, England, America)
Italy	2		
England	1		
America	2		

* A kilogram is equal to 2.204737 pounds.

† This is evidently a clerical or typographical error, as it makes the sugar produced nearly double the quantity of the raw material from which it was extracted. There are no indications that the countries of which this aggregate is reported received any supply of raw material from abroad. It should, probably, read 3,500,000 or 350,000. Sugar-beets are, in many localities, raised for stock-feed.

COMPARATIVE BEET-SUGAR PRODUCTION.

Countries.	1868–'69.	1869–'70.	1870–'71.	1871–'72.	1872–'73.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
France	213, 904	289, 324	289, 083	330, 000	400, 000
Zollverein	208, 140	217, 192	262, 987	182, 500	260, 000
Austria-Hungary	101, 602	151, 354	182, 280	162, 500	205, 000
Russia and Poland	87, 500	132, 500	135, 000	90, 000	150, 000
Belgium	37, 078	43, 552	55, 739	75, 000	80, 000
Holland, &c	10, 000	12, 500	17, 500	25, 000	35, 000
Total	658, 224	846, 422	942, 589	865, 000	1, 130, 000

LANDS IN THE SUGAR PARISHES OF LOUISIANA—CENSUS OF 1870.

Parishes.	ACRES OF LAND.		
		Unimproved.	
	Improved.	Woodland.	Other unimproved.
Ascencion	40, 091	40, 718	....
Assumption	39, 895	52, 854	1, 490
Avoyelles	38, 525	67, 952	17, 328
East Baton Rouge	50, 355	100, 084	4, 110
East Feliciana	73, 545	84, 765	23, 705
Iberia	19, 244	25, 324	36, 208
Iberville	32, 812	40, 755	103, 315
Jefferson	17, 806	12, 434	46, 757
La Fayette	58, 105	11, 732	44, 342
La Fourche	32, 820	60, 390	20, 145
Orleans	4, 603	3, 120	6, 725
Plaquemines	36, 777	15, 813	81, 963
Pointe Coupée	38, 166	48, 556	37, 078
Rapides	63, 265	145, 912	16, 989
Saint Bernard	7, 648	10, 591	12, 568
Saint Charles	15, 330	16, 734	5, 934
Saint James	26, 513	59, 762	17, 989
Saint John the Baptist	19, 880	23, 274	8, 585
Saint Landry	80, 452	141, 449	90, 877
Saint Martin's	33, 776	32, 646	37, 887
Saint Mary's	43, 564	61, 890	24, 008
Saint Tammany	1, 978	22, 083	....
Terre Bonne	36, 693	64, 913	28, 885
Vermillion	11, 524	3, 758	44, 042
West Baton Rouge	21, 628	25, 369	8, 332
West Feliciana	28, 810	62, 637	29, 277
Total	873, 805	1, 235, 515	748, 539

M. S. BRINGIER ON BAGASSE.

NEW ORLEANS, *September* 8, 1877.

DEAR SIR: Permit me to lay before you the result of a sugar-crop in Louisiana, and make upon it a few remarks.

Three hundred and seventy acres land produced 14,368,338 pounds cane, or 38,201 pounds per acre; this, put through the mill, yielded 8,021,304 pounds—55.8 pounds juice per 100 pounds cane. This juice evaporated left, in masse cuite, sugar and molasses, 1,190,987 pounds; 6,730,317 pounds water were evaporated and 2,838,430 pounds coal employed; so that each pound of coal only evaporated 2.37 pounds of water.

Masse cuite	1,190,987 pounds	= 8.29 pounds per 100 pounds cane.
First sugar	454,989 pounds	= 3.17 pounds per 100 pounds cane.
Second sugar	220,490 pounds	= 1.53 pounds per 100 pounds cane.
Molasses	515,508 pounds	= 3.59 pounds per 100 pounds cane.
Masse cuite		=14.85 pounds per 100 pounds juice extracted.

Now, 14,368,338 pounds cane contain at least 12,931,505 pounds juice. The last season the juice was very rich, and contained, at a low calculation, 18 per cent, masse cuite; but say that only 17 per cent. of it could be obtained, then 12,931,505 × .17 = 2,198,355 pounds masse cuite should have been obtained, and not 1,190,987.

The 1,007,368 pounds loss would have cost only the fuel employed in its manufacturing to evaporate 5,738,000 pounds of water; "one pound of coal should easily evaporate six pounds of water"; 956,440 pounds of coal, or 5,314 barrels, should do the work.

This is equal to		$2,657 00
500 hogsheads, $3.50, $1,750; barrels, 700, $1.35, $945		2,695 00
Manual labor for centrifugals, &c		648 00
		6,000 00
604,412 pounds sugar, at 10 cents	$60,441 20	
402,947 pounds molasses, at 3 cents	12,089 41	
		$72,530 61
		66,530 61

This would be twice more money than was cleared on the crop. Now imagine what is the loss and at what price sugar can be made.

Very respectfully,

M. S. BRINGIER.

Mr. W. G. LE DUC,
Commissioner of Agriculture, Washington, D. C.

[From the Department Monthly Report, January, 1873.]

SUGAR-MAKING IN THE FRENCH WEST INDIES.

A system of central factories has been adopted within a few days, in the French West India islands of Martinique and Guadeloupe, for the manufacture of sugar. The system is a substitute for the long-practiced method of making the sugar by individuals upon the plantations where the cane is produced. The design is to separate agriculture from manufacture, and by a concentration of capital, somewhat upon the co-operative system, to accomplish what the isolated planter was unable to do. The experiment, made upon a large scale during a series of years, it is maintained, has fully demonstrated the soundness of the principle. The central factories, or *usines*, as they are called, are owned by joint-stock companies, by which the sugar-cane is taken from the plantation and transported to the mill upon railroads, or tramways, constructed by those companies, a certain per cent. of the value of the cane being allowed the planter, the price being regulated by the market at Point-à-Pitre at the time the cane is delivered. The system seems to have proved a success, affording to the manufacturing interest a handsome profit, and, by leaving the planter free to devote himself to his peculiar vocation, largely increasing the cultivation of the cane.

The government of the island of Jamaica recently appointed a commission to visit the French islands and inquire into the working of this central sugar-factory system. The Department of Agriculture has received, through the Department of State, the report of these commissioners. Their examinations were made during the last summer, and the results, as stated by them, are not without interest and value to the sugar-producers of the United States.

The largest central factory in the French islands is that which is commonly called the "Usine d'Arboussier," at Point-à-Pitre (Saint Louis), the chief commercial station of the island. The factory is in the suburbs of this sea-port, and is constructed upon the grandest scale, having all the improvements in machinery and the manufacture of sugar devised by modern science. The cost of it was upward of a million of dollars, and its capacity of manufacture is equal to 10,000 tons of sugar during the first six months of the year, which is the manufacturing season. The process of manufacture, as described by the commissioners, is as follows:

"The canes are brought by the planter to a siding of the main tramway on his estate. The wagon generally carries two tons of canes, and one mule on a good level ordinary tramway can draw easily two wagons. The wagon, when brought to the mill itself, conveys the canes to the rollers. The *bagasse* being elevated by power to a platform over the boilers, the juice, on leaving the mill-bed, falls through three strainers into a tank, which has a double bottom, heated by steam. It is treated here with a little bi-sulphite of lime, and is then run into a montejus. This montejus, by steam, sends the juice up to the clarifiers, where it is heated in the ordinary way and tempered with lime properly. From this it is passed to the charcoal-filters, through which it gravitates, and then passes by a gutter into a receiver. From this it is passed to a montejus and is thrown up by steam into a cistern over the triple-effet.

From this cistern it gravitates into the triple-effet, passing from the first to the second, and from the second to the third boiler, as the attendant wishes. When it leaves the boiler it is immediately passed over new reburned charcoal. It gravitates through this and falls into another receiver, from which the vacuum-pan takes it up and boils it to sugar. The first-quality sugar is generally crystallized in the pan, and is then dropped into sugar-boxes, which stand seven feet from the ground; under these boxes a little charging-vessel runs on a railway that is hung from the bottom of the said boxes, and this vessel conveys the sugar over the centrifugals, where it is cured; the molasses from this being boiled up, when found in good condition, with the sirup of the following day. When this molasses is thick and clammy it is boiled into a jelly by itself and dropped into sugar-boxes, where it is allowed to granulate for a number of days. This makes the second-quality sugar, and the molasses from this, along with the skimmings and subsidings of clarifiers, goes to make rum. The juice that leaves the clarifiers does not pass over fresh charcoal, but follows the sirup from the triple-effet, thus assisting to wash out the sweets which may have been left by the sirup.

"The weight of canes delivered at the factory last year was 75,000 tons, although it was a season of drought. The factory can receive 100,000 tons a year. Last year 5,325 tons of sugar were obtained from 68,725 tons of cane, or about 7¾ per cent. In April last the factory company declared a first dividend of 24 per cent. In other words, a net profit of $181,585 was made upon the manufacture of 68,745 tons of sugar and 182,798 gallons of rum.

"The processes of manufacture in all the factories, both in Guadeloupe and Martinique, are identical, the only difference being the adoption in the new factories of the appliances of modern science, and improved mechanical and other arrangements. The clarification of the juice, its reduction to sirup at a low temperature, the perfect crystallization and color of the sugar, and a maximum return, are obtained by repeated filtration through animal charcoal, the 'triple-effet' and vacuum-pan processes, and, last of all, centrifugal machines. In Martinique the mean weight of canes was found to be equal to 28 tons per acre, producing, say 2¼ tons of sugar, and the sugar sells at $200 a ton.

"The central factories, or usines, are represented as in the highest popular favor. Capital, both local and in France, is freely subscribed to establish new usines upon a large and extensive scale. Eight of the factories, at considerable cost, have been erected within the last two years, and others are now in process of erection. They seem everywhere, by increasing the facilities of manufacture, to have stimulated the planters to increased production of the cane. In speaking of the difference between the tillage of those who sell their canes to the usines and those who manufacture at home, it is remarked that in the one case the canes are no sooner out of the fields than the gangs and stock are at work preparing the land for the next crop, and all the fields are tidy and clean. In the other case, fields are left to take care of themselves until the crop season is over. Estates which, before the establishment of the usines, were in debt, are now said to be in a flourishing condition, and others which had almost fallen out of cultivation are now making excellent crops.

"In most of the factories hydraulic or other presses are employed for extracting the remnants of juice from the skimmings. The former are carefully returned to the clarifiers, the residuum being a hard cake, which is used for fodder and manure."

REPORT OF THE SUPERINTENDENT OF GARDENS AND GROUNDS.

SIR: I have the honor to submit the following report upon some of the operations of this division during the past year, with remarks on various subjects in response to inquiries and suggestions made by correspondents of the department.

In order to correspond with the amount appropriated for the maintenance of the grounds, and for purposes of propagating plants, it was necessary to reduce the working force previously employed. This reduction has precluded the possibility of preparing the usual number of plants for distribution, especially of those that require deliberate manipulation, such as the grafting of orange stocks, of which many thousands had to be abandoned, the propagation of olives, of Japan persimmons, grapes, fiber plants, &c.

For the same reason no additions have been made to the arboretum. The plants already established are progressing favorably, both in regard to displaying their individual characteristics of habit of growth and peculiarities of form, and the general landscape effect to be developed from their combination and grouping.

A further extension of the lake surface having been decided upon, for the better accommodation of hardy aquatic plants, a commencement was made some months ago, and the work will be prosecuted from time to time, as leisure offers opportunities from more pressing operations, until it is completed.

RUSSIAN APPLES.

Several years ago the department imported from Russia a collection of apple-trees, under the supposition that their introduction might result in adding to the list of hardy varieties of this fruit suited to the most northern regions of the country. These were planted in the grounds here, and scions from them have been freely distributed, from time to time, in various sections both North and South; some of these have already produced fruits which have been reported upon as giving promise of value. About one-half of the originally received trees have fruited here, and although many of them do not appear to reach the standard of excellence that will enable them to compare favorably with similar products here, yet there are some of more than mediocre value, and that promise to be worthy of culture even here as very early varieties. The object of their introduction, as already remarked, was for the purpose of experiment in the Northern States, so that their behavior here is no criterion of their value for the localities mentioned. Numerous calls have been made for a descriptive list of these apples, as valued in Russia, including the soils best adapted to them, their earliness, lateness, keeping qualities, and information of a similar kind, none of which would be of value to us here, even if it were practicable to procure it, which it is not. The only mode of ascertaining their adaptability or usefulness in any part of this country is to test them. Happily there is no lack of fruit-growers who are willing to make such experiments, and as soon as results are ascertained and reported, they will be published for the benefit of all.

CHINESE TEA (THEA VIRIDIS).

That the Chinese tea-plant can be grown over a large extent of territory in the United States is well known. The department has been distributing tea-plants for many years past, and in considerable quantities, throughout those parts of the country where the climate will admit its permanent growth without protection. These distributions have not been made for the purpose of testing the hardiness of the plants, as many persons at this late day seem to suppose, but with the avowed purpose of aiding in their dissemination as a means toward the production of a profitable industry, under the belief that when the principles involved in the preparations of tea came to be fully understood, it would prove to be a fairly profitable crop, quite as much so as others of the staple productions of this country. The opinion is very popular that labor is too high-priced here to enable our planters to compete with the Chinese in tea-culture; an opinion which would seem to require some explanation, when taken in connection with other popular statements, to the effect that tens of thousands of our laboring population are at present unemployed and are dependent upon charities for their bare food support. So far as the culture of the plant is concerned, its requirements are similar to those ordinarily given to an apple or pear orchard, or, more precisely, those of a gooseberry or currant plantation. The tea-plant is set out in rows about five feet apart, and can be cultivated as between similar lines of cotton or corn. The mere cultivation of the plant is therefore no more expensive than is that of any other farm crop, and much less than the cost of the products of the fruit or the vegetable garden.

The harvesting of the crop and its preparation for market are therefore the only points to be considered as presenting unusual, difficult, or extra expensive operations. With regard to the first, picking and gathering the leaves, it is possibly the only operation in the whole system of tea preparation where no substitute can be found for hand labor, and, upon the whole, presents no greater obstacle to profits than does that of picking cotton, gathering peanuts, or any of the smaller market fruits.

The young points of the shoots, each containing three or more leaves, are pinched off between the thumb and finger and thrown together in a bag or basket, to be conveyed to the drying-rooms. Experts have been known to thus collect twenty pounds of the leaves in a day; sixteen pounds daily per hand is less of a rarity, and twelve pounds an average. Four pounds of fresh leaves make one pound of dried tea.

Then as to drying, roasting, sifting, and the numerous other details with which tea manufacture is in some measure mysteriously surrounded, it may be stated that the philosophy (if it may be so termed) of tea manufacture is well understood; that many of the Asiatic processes and manipulations are traditional rather than indispensable, or even necessary. Others again are commercial exactions which need not be considered here, and which are only rendered necessary in order to prepare the product for distant voyages, to its manifest and acknowledged injury as an article of consumption.

Then, again, even should tea ever become an article of export from this country, and the necessity arise for preparing it for transportation, machinery can be employed for the drying, roasting, and twisting processes, as it is now used on the tea plantations in British India and in other parts of the world; and it may be surmised that improved labor-saving machinery will speedily be produced, as inventors have only to be shown what is wished to be done and they will furnish a machine to do it. The great progress that has been made in tea culture and its manufacture throughout the world during the past twenty-five years seems to be utterly unknown to, or overlooked by, many of the correspondents of the department, who doubt the propriety of experimenting with the tea-plant in the United States, although there probably never has been an introduction of a new industry in any country which had not to encounter similar doubts and prognosticated failures.

One of the most important requirements of the tea-plant, for profit, is a climate or region where spring rains are abundant; young growths are encouraged by moist weather and heat, and the number of successive crops that can be procured from the plants during the season is entirely dependent upon the number of rainy periods and the abundance of the rain-fall during the early summer months.

ACCLIMATIZATION.

The question of acclimatization of plants is frequently alluded to by correspondents of the department, in connection with the introduction of economic species and their cultivation, as subjects of commercial importance. The coffee-plant, for example, it is held by some, may be acclimated in Louisiana. The same opinion is held in regard to other tropical products which are now imported for use.

The process by which acclimation is to be accomplished is in a general way supposed to be through the agency of raising plants from seeds, with the hope that through successive generations the plants will gradually become adapted to the conditions surrounding them, and that by this means the descendants of a tropical species may ultimately become inured to a very different climate from that where the original was found. It has long been supposed that the sensibility of plants to cold or to heat may be modified by persistently selecting seeds from those plants that show indications of greatest hardiness, and that such changes do occur to a limited extent is quite apparent. In proof of this we may refer to the great variety of our common cultivated vegetables; of these we have early and late varieties, comprising great differences in size, quality, shape, and color, as well as in their ability to withstand sudden changes or extremes of temperature. Perhaps there is no plant that displays such diversity of forms from a common origin as those of *Brassica oleracea*, the common cabbage. Of these, the varieties are almost without number, varying in hardiness from the hardy winter-cabbages to the tender broccolies and cauliflowers. It does not appear, however, that any one of these numerous varieties is more hardy than the species; on the contrary, some of them, such as the cauliflower and broccoli, are more tender. We have in the tomato an annual plant that has been grown from seed for upward of a century in gardens, and of which many varieties exist, showing great diversity in the shape, size, and color of the fruit, as also in their periods of ripening, some being early, others late, but all being as susceptible of injury from cold as the original species.

As an example of a variety being hardier than the species, we may cite the *Magnolia grandiflora*, var. *exoniensis*, which will retain its leaves uninjured during winters cold enough to destroy young branches of the species in its immediate vicinity. The influences of climate are also illustrated in the experience of nurserymen in Scotland, who find that the *Pinus sylvestris*, when raised from seeds received from Germany, is so tender as to become "browned and scorched" during winter, and especially from the frosty breezes of early spring, while plants of the same age, the offspring of seeds gathered in the neighborhood, have a fresh green appearance all through winter and spring, and rapidly grow into sturdy trees, while the others are said to be utterly worthless in exposed situations, and only succeed in some sheltered localities. These facts, while they prove that certain changes occur, also suggest that the range of the change is limited, or at least beyond a certain limit the change is exceedingly slow. The various discoveries of the fossil remains of tropical plants in different parts of the temperate zones, together with other deductions from the geographical distribution of plants, may caution against making the positive statement that it is an impossibility for a tropical plant to ultimately change its character and habits so as to become fitted to grow in the temperate regions of the earth; but, allowing the possibility, it is one of those slow processes in nature of which history makes no mention, and, so far as it can be made useful in practical economics, is a myth.

Another series of reasonings which appear theoretically plausible, but in the main are practically unreliable, are those which proceed upon the hypothesis that a corresponding degree of latitude will have a corresponding climate in all parts of the world, or that a plant will grow equally well in all countries that have a thermometrical temperature similar to that of which it is a native. There are other potent factors to be considered besides that of the temperature of the air, so far as it relates merely to cold or heat, such as the topographical features of a country, the amount of rain-fall, of sun-heat and light, and, what is of the most importance, the hygrometrical state of the atmosphere.

That the amount of cold that plants will endure depends upon other conditions besides that shown by the thermometer is well exemplified in the vegetation of Australia. Few, if any, of the plants of that country will stand the same amount of cold with us that they are subjected to in their native habitats. Many hundreds of Australian plants have been tried here during the past decade, and among them all, acacias, Eucalypti, Pittosporums, Boronias, &c., not one has been found to withstand 8° of frost uninjured; yet, as the following extracts will show, these plants are often subjected to 20° of frost in Australia:

In the end of April (our October), in latitude 82° south, within 4½° of the tropic, at an insignificant elevation, the thermometer stood at 20° at sunrise, and was as low as 43° at 9 p. m., nevertheless the country produced wild indigo, Mimosas, Casuarinas, and Myrtles. A degree nearer the tropic in May (our November), the thermometer at sunrise marked 20°, 19°, 18°, 16°, 12°, and on two separate days even 11°.

On the 22d of May (our November), the river was frozen, and yet herbage was luxuriant, and the country produced Mimosas, Eucalypti, and Acacias. On the 23d of May, the thermometer at sunrise marking 12°, *Acacia conferta* was coming into flower, and Eucalypti, with the usual vegetation, were abundant. On the 30th of May, at the elevation of 1,118 feet, the almost tropical *Delabechea* was found growing, with the temperature at sunrise 22°, and at 9 p. m. 31°, so that it must have been exposed to a night's frost gradually increasing through 12°. And this was evidently the rule during the months of May, June, and July (our November, December, and January); in latitude 26° south, among Tristanias, Phebaluims, Zamias, Hoveas, Myoporums, and Acacias, the evening temperature was observed to be 29°, 22°, 37°, 29°, 25°, falling during the night to 26°, 21°, 12°, 14°, 20°; in latitude 25° south, the tents were frozen into boards at the elevation of 1,421 feet; the thermometer, July 5, sunk during the night from 38° to 16°, and there grew Cryptandras, Acacias, Bursarias, Boronias, Stenochiles, and the like. *Cymbidium canaliculatum*, the only orchidaceous epiphyte observed, was in flower under a night temperature of 33° and 34°, that by day not exceeding 86°. It may be supposed that so low a temperature must have been accompanied by extreme dryness, and such appears to have been usually the case; nevertheless, it is not always so, for it was found that on the 22d May, when the hygrometer indicated nearly saturation, the grass was covered with hoar frost, and at sunrise the thermometer was 20° under canvas and 12° in the open air. On the 5th of July it rained all day, and the tents were "frozen into boards" next morning, the thermometer having sunk during the night from 38° to 16°.

Undoubtedly this power of resisting cold is connected with the very high temperature to which Australian vegetation is exposed at certain seasons, which so thoroughly ripens and hardens growth as to fortify against the evil results that follow extremes of heat or cold on succulent vegetation. The temperature of the soil has also an important controlling influence in the cold resisting-power of plants. Unless a constant supply of moisture is furnished by the roots, the branches will dry up and shrivel under the influence of cold drying currents of air, and when the temperature of the soil is low, the activity of the roots is correspondingly decreased, and therefore they are unable to replace the losses of evaporation from the external surfaces of the plants. The winter temperature of the soil in which plants are growing has a potent influence on their cold resisting-powers; hence the value of the applications of manure and similar porous materials over the roots of plants in winter.

EUCALYPTUS.

The general interest in the introduction of this genus of Australian trees is still maintained, and it is almost a daily occurrence to reply to inquiries relating to their culture, value, climatic range, &c.; and while the *E. globulus* is the species about which the greatest expectations have been raised, latterly the subject seems to have taken a wider range, and information is sought regarding the values of other species of this large family of trees.

The *E. globulus* has been brought more especially into notice on account of its rapid growth, which was the supposed reason for the power attributed to it of destroying the malarious agency which is considered to cause fever in marshy districts, but so far as mere rapidity of growth is concerned, or the influence that an abundance of healthy, active foliage exerts in absorbing moisture from the soil, the *Eucalyptus* presents no special peculiarities over those inherent in many other trees and plants that are rapid in growth and furnished with a profusion of ample-sized leaves.

It may therefore be instructive to recite the accorded values of other species of the *Eucalyptus* genus, especially as some of them are alpine in their native habitats, and may prove hardy in higher latitudes than those that limit the *E. globulus.*

It is noteworthy that in Australia the *E. globulus* does not hold the highest position in regard to anti-malarial properties, although its products are highly esteemed. The supposed sanitary properties of these trees are, in their native country, referred to the chemical constituents peculiar to the genus, regardless of the rapidity of their growth or the dimensions they attain.

In a paper* upon *Eucalyptus* read before the Royal Society of Victoria in 1874, and which is published in the official catalogue of the Commissioners to the Centennial Exhibition for Victoria, Australia, there is much valuable information regarding the properties and qualities of various species of the *Eucalyptus*, and from which the following extracts of particular interest with reference to the introduction of these trees into this country are taken:

In many places on the continent of Europe, and elsewhere, experiments have been made to acclimatize our *Eucalypti*, more especially the "globulus," or blue-gum species.

The rapidity of its growth, its pretty ovate and, afterward, lanceolate leaf, its early maturity, together with its power to absorb considerable moisture and to permeate the air with its peculiar odor, led to the belief that this tree, attractive in itself, exerts a beneficial influence upon malarious districts. But this species, if considered apart from its congeners, does not supply sufficient information so as to arrive at anything like a satisfactory answer to the question—

Is the *Eucalyptus* a fever-destroying tree? In the consideration of this question we must regard the whole of the *eucalypt* vegetation.

If we journey from Melbourne, or from other centers of population in any part of Australia, or diverge to any point of the compass, we immediately observe the *Eucalyptus*, which is seldom absent until we again enter some city or town; in fact, four-fifths of Australian vegetation consists of the *Eucalyptus*.

In the consideration, therefore, of its climatic influence, or of its health-producing power over that of all other vegetation existing in other countries, we are able more efficiently than elsewhere to deal with the subject. * * * *

Australia on the whole may be said to be pretty free from virulent endemic or miasmatic fevers, and the latter may be said to exist only as the *Eucalyptus* recedes.

The physical geography of Australia does not differ in its general outline from that of other countries. We have mountains and valleys, high ranges and extensive plains, rivers and creeks, and in general structure, character, and composition, in geological sequence, and in physical and palæontological relations, the rock formations are in all respects analogous to those of other regions.

But in the *Eucalypti* we have a vegetation absolutely Australian; if, therefore, we possess in a high degree an immunity from fever maladies, can it be traced in any way to this genus of plants? * * * * * * * *

The physical properties of all *Eucalypts* are, that they cast their bark; that the leaves are ever green and have translucent cells, in some species visible to the naked eye; that the petiole is half twisted, so that the plane of the leaf is parallel to the axis of the tree, thereby allowing free action to the light and heat of the sun *on both sides;* also the roots are dispersive and drain water largely from the soil.

* This paper was prepared by Mr. Bosisto, M. P., one of the commissioners.

The chemical contents of a *Eucalyptus* tree are neither poisonous nor virulent. Besides possessing those invariably met with as general constituents of ligneous vegetation, there is a *tannate gum resin*, a *volatile acid*, and a *volatile oil*, peculiarly of *Eucalyptic* origin.

The first two are to be found in most parts of the tree, but the latter only in the leaves. Now, it is in these three bodies, I think, that we have the key to the question before us, and I conjecture that apart from these no trace can be found of the power of the *Eucalyptus* to oxygenate the air beyond that which is possessed by other kinds of vegetation. If the principles of these bodies are retained in the tree until set free by the art of man, then further investigation is useless; but if one or more are given up freely by the natural forces of the tree, or by the aid of light, heat, or electricity as existing in the atmosphere, or by some or all of these forces in combination, then there is every reason to pursue our inquiries. The question then arises, have we any proof that these volatile bodies are set free in the air by the forces of the plant in union with atmospheric agencies? If we have, when does it take place? What is the quantity? What is the probable sanitary effect?

Before taking up this question, I think it but right to mention that my operations on the *Eucalyptus*, both as to its solid and volatile contents, for technical and medical purposes, have extended over many years, and that they have been conducted on the living plant in its forests and in the desert scrub during all seasons of the year, and that the apparatus employed operated on four tons of material daily.

The following eight may be taken as representative or type species of *Eucalyptus*: 1. *Viminalis*, or manna-gum; 2. *Odorata*; 3. *Rostrata*, or red gum; 4. *Obliqua*, or stringy bark; 5. *Sideroxylon*, or iron bark; 6. *Globulus*, or blue gum; 7. *Oleosa*, or mallee; 8. *Amygdalina*, or peppermint.

The first two, *Viminalis* and *Odorata*, represent those species of the Eucalypti which yield a small percentage of volatile oil. The four following, the red gum, the stringy bark, the blue gum, and the iron bark, represent those species which gradually increase in percentage of oil until it attains a fair medium standard; and the last two, the mallee and the peppermint, are those which represent the maximum.

The following is the illustration: From 1,000 pounds weight of fresh-gathered leaves, attached to very small branchlets, *Odorata* yields 7 fluid ounces; *Viminalis* yields the same; *Rostrata* yields 15 ounces; *Obliqua* yields 80 ounces, or 4 pints; *Globulus* yields 120 ounces, or 6 pints; *Sideroxylon* yields 160 ounces, or 10 pints; *Amygdalina* yields 500 ounces, or 25 pints.

No Eucalypti exceed the *amygdalina*, and no vegetation contains so much volatile oil in the leaves as is found in most of the species just named. These eight species not only represent the oil-yield from the minimum to the maximum, but also the volatile acid and the tannate gum-resin, as well as the locality, from mountain to desert.

First, then, concerning the volatile oil. If we break up a leaf of any of the Eucalypti during any part of the year, its usual aroma is present, and the oil-cells appear the same in condition; but when submitted to a practical test, the quantity is found to vary. Soil or locality does not appreciably affect the quantity obtained from a species when operated upon during the same season of the year.

The range of those species represented in the *viminalis* and *odorata* as yielding oil sparingly is limited, in comparison with those producing larger supplies. These have a wide range. * * *

The *Eucalyptus amygdalina* is a tree varying from that of an ordinary willow to that of the giants of the forests, some being over 350 feet in height; it occupied chiefly the higher portions of undulating forest-land and the sides of the ranges, and does not extend over 100 miles inland; the ground where it grows retains a little moisture throughout the summer months, the roots run chiefly lateral, and are seldom lower than three feet from the surface; they are surrounded with a soil evenly cool, but the temperature of the air has its usual summer range. During these months the supply of oil from week to week is very even, but as the cooler or winter months approach, the ground becoming moist from rain, and the temperature of the air lower, the supply of oil falls off.

The mallee scrub is the opposite of all this. Properly this scrub consists of three species, the *oleosa*, the *dumosa*, and the *socialis;* but I have brought them under consideration as one, the *oleosa*. They are the dwarfs of the Eucalypti, but seldom growing higher than 25 feet. They occupy a flat, dry, hungry country, with but little growth of grass under them. There is little rain, but when it comes, it is generally in torrents. The soil is a reddish sand in combination with salt clay. This, during the long droughts, becomes exceedingly hard—so much so that a pickax is required to turn the soil. The roots run somewhat in a horizontal direction, and the rootlets spread out, traveling downward; and as the salt water is to be obtained always at from 25 to 40 feet, they are found resting on the moisture of the salt soil just above the sandstone rock, which generally commences about 12 feet above the salt spring. The temperature of the surface ground, and also that of the air, is very high throughout the summer. The leaves supply a greater amount of oil during the winter or rainy season than during the hot or summer months.

We have, therefore, a *Eucalyptus* vegetation charged to its utmost during summer around all our populated districts, and we have another charged in like manner during winter; in other words, as midwinter approaches, the coast species are increasing in volatile products and the others are decreasing. * * *

So far our evidence of oil-evaporation may be stated thus: that the desert scrub-gums, after a winter of average rain-fall, supply the air with a continuous and even quantity of aromatic vapor, and keep up a vigorous vitality throughout the summer or dry season; and that a short season of rain and a long dry one diminish the formation of oil, and so lessen the exhalation; on the other hand, the seaward species increase their quantity after a short winter.

Next concerning the volatile acid.

Eucalyptus leaves (especially those of some species), when submitted to the process of ordinary distillation by steam or water for volatile oil, throw off a volatile acid which greatly affects the copper head of the still—so much so, that on lifting it off we find the under surface covered with what is like a coat of slate-colored paint. After the copper head has been used for some time, this paint-like substance dries into scales having a slate-pearly appearance.

If the distillation has been by water, and the mother-liquor remaining in the still is subjected to a little evaporation, this acid may be detected in the vapor by litmus-paper. Should the evaporation be carried to further concentration, the acid aroma becomes palpable around the locality of operation, persistent, and very refreshing; in short, there is no expelling this acid out of the gum-resinous extract forming in the pan. The aroma of the acid may be detected in the air along with that of the oil when traveling in the bush.

The special features of this acid as existing in all Eucalypts are, that in those species supplying oil most abundantly the acid is *not so prominent* as it is in those yielding the medium quantities, while those species which contain oil sparingly contain also but little of the acid. In like manner this applies to the resin bodies. And these facts are worthy of particular note, as they go to show, first, that those species yielding largely of oil are not so abundant either in resin or acid, and that those of medium oil-yield are well charged with both. In proof of this, the *amygdalina*, our largest oil-producing species, during its active period of supplying the volatile oil, does not throw off much resin; but when it begins to lodge in the interstices of the bark and wood and exudes outwardly, the oil is diminished in quantity in the leaves.

The *globulus*, or blue gum, yields a continued supply of oil and acid throughout the year; but when the tree is extra resiniferous, the acid is abundant and the oil small in quantity.

The *rostrata*, or red gum, produces a very small quantity of oil, but the volatile acid is very abundant—so much so, that the red-gum wood owes its aroma entirely to this acid.

The *sideroxylon*, or iron bark, are trees of good dimension, and supply oil abundantly, but the leaf-surface on each tree is small in comparison with other species. Here the resin is so abundant that its enormous bark is everywhere studded with gum-resin.

All these characteristics, and others of like nature, point to the following conclusion: That the volatile oil is the base of the other products peculiarly of eucalyptic origin, and for the following reasons: that those species which are great in the production of oil supply it vigorously to the atmosphere, giving but little time for the formation of substances such as resins and acids, requiring the absorption of oxygen by the leaf to form them; on the other hand, those species less vigorous in oil-production allow time for the purpose, hence they become well stored with resin and with the acid. * *

When we consider the extent of this vegetation, we cannot arrive at any other conclusion than that the whole atmosphere of Australia is more or less affected by the perpetual exhalation of these volatile bodies.

The researches of Schonbein and others relating to the change the oxygen of the atmosphere undergoes by electricity and by other known oxidizing agents, suggested a similar province for the aroma of plants and flowers, and Dr. Andrews, of Edinburgh, states that "volatile oils, like phosphorus, have the power of changing oxygen into ozone while they are slowly oxidizing." Unless some such change took place in the air, the aroma of the oils of the Eucalypti would be always present, and to such an extent as to become quite unpleasant.

Ozone, or whatever may be the active substance in the atmosphere, is known to act in a similar manner on iodide of potassium and some other chemicals; and Dr. Day, of Geelong, whose researches on this subject are well known, has demonstrated that the *Eucalyptus* oils absorb atmospheric oxygen, transforming it into peroxide of hydrogen. If the change effected be the production of ozone, and the latest known experiments on the subject, confirmed by Dr. Andrews, appear to leave no doubt that this is the case, then another link is added to the evidence that the *Eucalyptus* vegetation has an important action on climatic influences. Dr. Andrews remarks that "no connection has yet been proved to exist between the *amount* of ozone in the atmosphere and the occurrence of epidemic or other forms of disease"; but remarks, "its absence from the air of towns and of large rooms, even in the country, is probably the chief cause of the difference which every one feels when he breathes the air of a town or of an apartment, however spacious, and afterwards inhales the fresh air of the open country." Let a small quantity of any of the *Eucalyptus* oils, but especially the oil of *Eucalyptus amygdalina*, be distributed sparingly in a sick chamber, or over any unpleasant substance, or add a small quantity to stagnant water, and the pleasure of breathing an improved air will immediately be manifest. The application of this to the climate of Australia has great force, for it is acknowledged that we possess about us, both in bush and town, a large amount of active oxygen, made frequently doubly so by our vigorous vegetation. * * *

The various fever types as found existing among us at times appear malignant, arising either from importation or from the existence of bad sanitary regulations; but medical testimony is that their virulence is meteor-like, "dies at its opening day." No credit can be taken for any improved sanitary condition of our surroundings by ourselves in our towns and cities. The influences operating there *entice* the poison fever germ to fructify and abound. The evidence is in favor of the *Eucalyptus* being a fever-destroying tree.

Other properties and uses of the genus *Eucalyptus* may here be noticed. The remarkable solidity, hardness, and durability of the timber of some of the species is well known. The large proportion of potash, amounting to 20 per cent., in the ashes of these trees has been pointed out by Baron Von Müeller. The barks of *E. rostrata*, *E. obliqua*, *E. goniocalyx*, and *E. corymbosa* are used for making paper. The barks of many species are used extensively for tanning. A substance called Australian manna is yielded by *E. mannifera*, *E. viminalis*, and other species. This manna occurs in small, rounded, opaque, whitish masses, with an agreeable sweetish taste; it contains somewhat similar constituents, and has similar action to the ordinary manna, and exudes in large quantities through punctures or wounds made in the young bark. Another product of great importance is the essential oils. These oils generally have a camphoraceous smell, the odor differing in the various species; that from *E. citriodora* has a pleasant citron-like flavor. The oil from *E. oleosa* is used as a solvent for resins in the preparation of varnishes. The oils of *E. amygdalina*, *E. globulus*, and *E. citriodora* are used for diluting the more delicate essential-oils used in perfumery. These oils contain a substance called Eucalyptol, a liquid body, having chemical characters resembling camphor.

The febrifugal properties of the bark and leaves of *E. globulus* have been noted by many medical practitioners. Although careful examination of the bark and leaves has proved that neither quinine nor the other alkaloids of Cinchona bark exist in the plant, yet it is admitted to possess antiperiodic properties, which are supposed to be due to the presence of Eucalyptol.

Finally, cigarettes made of *Eucalyptus* leaves are reputed to be useful in bronchial and asthmatic affections. Considering the rapidity of growth, the value of the timber, the healthy emanations from the foliage, the commercial importance of the essential-oils, and the beauty of the different species of the genus, it must be conceded that the *Eucalyptus* is one of the most important family of forest trees known at the present time, and that they should be extensively planted wherever climatic conditions are favorable to their growth, with the further reminder that the *E. globulus* need not be taken as a criterion of the hardiness of the genus in low temperatures, since the more alpine species are known to flourish where the *E. globulus* has failed.

The purpose of these detailed remarks upon the genus is to show that the supposed sanitary value is not confined to one species, but that the whole family are possessed of oil-bearing leaves, and that, therefore, further experiment with the hardier species may be profitable.

ORANGES.

The following notes on oranges are taken from a valuable paper by John R. Jackson, of Kew, which appeared in the "Garden:"

Regarding the early history of the orange, a good deal rests upon what is the true and original form whence sprung our numerous cultivated varieties. All those included as bitter and sweet oranges are referred by some botanists to *Citrus vulgaris* (Risso), a native of Northern India; indeed it is supposed that a wild form which occurs in Gurhwal, Sikkim, and Khasia is the origin of all our cultivated forms. It has further been considered that the Citron, Lemon, Lime, and Shaddock, and even the Orange, are all referable to a species indigenous also to the forests of Northern India, in the valleys of Kumaon and Sikkim, and perhaps specifically identical with *Citrus medica* (Risso). Upon the hypothesis of this being the original form of the now widely-cultivated orange, we learn from Theophrastus that it was plentiful in Northern Persia, and cultivated by the Jews in Syria during the Roman dominion. Though it seems that the fruits found their way into Rome at a period anterior to the Christian era, the tree appears not to have been successfully cultivated in Italy till some time in the third or fourth century. However widely diffused the plant may have been in Western Asia, recent travelers have not found it in a wild state in Persia.

In China it is cultivated, having no doubt been introduced from an early period. At the present time the growth of the orange extends over all warm countries, and it is cultivated successfully in many colonies. In America it yields most abundant returns.

Orange (*Citrus vulgaris*, Risso). Under this head may be placed both the Sweet and the Bitter orange. By those who do not so class them, however, the former is often referred to *C. Aurantium* (Risso) and the latter to *C. Bigaradia* (Duhamel). The Sweet orange has ovate, oblong, acute leaves, the edges somewhat serrated, and the stalk with larger or smaller wings, the presence of which is a characteristic mark of the genus. The white, fragrant flowers are too well known to need any description. The principal difference in the numerous varieties described is in the form of the fruit; thus we have the ordinary Sweet or Saint Michael's orange, with its somewhat small, golden-yellow fruit, divided into from nine to eleven cells, and containing roundish seeds. This is one of the most extensively cultivated varieties, on account of its great productiveness. The tree is said, however, not to come into full bearing until it attains the age of twenty years. The Blood or Malta orange has a fruit which is round, somewhat rough, and very thin-skinned, and as it ripens becomes of a reddish-yellow color, the pulp itself being tinged with red, which deepens as the fruit matures. This variety has very few seeds, which are barren. It is a choice variety, the pulp being very sweet and juicy. Another choice variety is the Mandarin orange. This bears a small fruit, somewhat flattened, with a very thin rind which separates from the pulp as the fruit ripens, and when fully ripe hangs loosely around it. It is of a very rich and sweet flavor. This variety is extensively grown in China, where the fruits are much prized as presents to the mandarins. It has been introduced in comparatively recent years into Malta and St. Michael's. The Mandarin orange was at one time considered a distinct species, under the name of *C. nobiles* (Lour). It seems, however, to be simply a variety of the common orange, as is also the Tangerine, which produces small, somewhat flattened fruit, with a thin rind, and a sweet, delicious, fragrant pulp.

Among bitter oranges the most important, either in a commercial point of view or on account of the peculiarity of their fruits, are the following: The common bitter or Seville orange (the *Bigaradier* of the French); a fruit with a thick rind, and a rugged, uneven surface of a reddish orange color. The rind, flowers, and leaves are more distinctly aromatic than those of the sweet orange, and the pulp has an acid, bitter taste. It is the fruit of this variety that is used for making marmalade, and the peel is used for candying and making medicinal tinctures. The rind is removed from the ripe fruit in long, spiral strips by a sharp knife—if removed without the white under-skin it is the more valuable. The tree is of a small size, and is extensively cultivated in the warmer parts of the Mediterranean region, more particularly in Spain.

This variety and the Chinese Bitter orange, or Chinois (the *Bigaradier Chinois* of the French), are perhaps the only two cultivated purposely for the fruits. This latter has a thick rind, the fruit is small and spherical, and is often preserved in sirup. Many of the fruits of the bitter oranges are very singular in form, notably the Horned variety (*Bigaradier à fruit corniculé*). This variety grows into a good-sized tree, and is cultivated in the south of Europe as much for the sake of its fragrant flowers as for the fruits, which were at one time, and may be still, used for flavoring or seasoning meat. A double-flowered variety, the *Bigaradier a fleur double* of the French, comes nearest perhaps to the Horned variety, resembling it in the form and size of the tree. The fruit varies in form, but is mostly double, containing, so to speak, one within another. The flowers are gathered for the sake of their perfume.

Another variety, *Bigaradier violette*, bears leaves and flowers of two different colors on the same plant, some being of a violet hue and the others of the ordinary color;

the fruits also, in an immature state, have a violet tinge. The small-growing myrtle-leaved orange is also a variety of this class.

Lemon (*Citrus limonum*, Risso; *C. medica* var. of some authors). Of the Lemon a very large number of varieties are in cultivation. In all, however, the fruits contain a very acid pulp, distinct from any other species or variety of the genus. A very large-fruited variety is described as having been introduced and much cultivated in Jamaica, from a single fruit of which a pint of juice has been obtained. The common lemon is a tree from ten feet to fifteen feet high, specially cultivated as an article of commerce on the coast of the Mediterranean, between Nice and Genoa, as well as in Sicily, Calabria, Spain, and Portugal. As seen in cultivation, the lemon, unlike the orange, is of irregular growth, with sparse foliage. The flowers are partly hermaphrodite and partly unisexual, and the corolla is purplish on the outside and white within. Their fragrance is more delicate than, and not so clinging as, that of the orange. The trees blossom during a great part of the year except the actual winter. The lemon assumes many peculiar forms, among the most singular of which is the Fingered Lemon of China.

This fruit grows to a large size and is almost solid, with little or no pulp; at the apex of the fruit the segments become absolutely divided into five or more long, cylindrical lobes, hence the name. Among those noted for their free-flowering and abundant fruiting is the Clustered Lime or Lemon (*Limonier à grappes* of the French). The leaves of this variety are oval, oblong, and the flowers, which are borne in corymbs, are succeeded by clusters of roundish-oblong fruits often somewhat warted on the surface, the rind being thick and shining, and the pulp very acid, and containing only a few seeds. This variety produces fruit abundantly during a great part of the year, and is cultivated largely in Southern Europe.

Citron (*Citrus Media* (Risso) *Cedrat* of the French). This species is now usually retained as the origin of all the fruits previously considered. The Citron occurs in fewer varieties than either the orange or the lemon. The most common is the large citron (*Cedratier a gros fruits*); in this the leaves are thick, oval, oblong, and of a glaucous green, and the flowers are large and white and very numerous; the fruit also is very large, covered with a very thick, irregular, or wrinkled rind, at first of a reddish-purple color, becoming green as the fruit enlarges, and finally changing to a coppery hue.

It is for its thick rind that the citron is valued for the purpose of candying or preserving in sugar for use in confectionery; for this purpose the peel is salted and shipped to various parts. The fruits themselves, which often weigh several pounds, are seldom eaten raw. The citron appears at the present day to be nowhere cultivated extensively, the more prolific lemon-tree having generally taken its place. It is, however, scattered along the Western Riviera, and is also grown on a small scale about Pizzo and Paola, on the western coast of Calabria, in Sicily, Corsica, and the Azores.

Bergamot (*Bergamottier* of the French). *Citrus Bergamia* of some authors, though modern botanists consider it not sufficiently marked to make it a distinct species from those preceding. It is a small tree, in flowers and foliage not unlike the Bitter Orange; the fruits are nearly spherical or somewhat pear-shaped, very often crowned at the apex by the persistent style; they have a smooth, thin skin, of a pale-yellow color, and this skin contains a large quantity of essential oil, of a peculiar but well known fragrance. It is for this oil (the oil of Bergamot of the shops) that this variety is valued, being cultivated on low grounds near the sea at and in the neighborhood of Reggio, in Calabria, where lemon and orange trees are often mixed with it. The essential oil is expressed from the fruits by specially constructed machinery by which the fruits are made to revolve in a kind of dish or saucer, at the same time coming in contact with a series of metal ridges, which fracture the rind and thus set free the oil. From 2 ounces to 3 ounces of this oil is so obtained from every 100 fruits, and about 7,000 fruits are thus treated by a single machine in one day. After the oil has been extracted the fruits are again pressed for the sake of the acid juice contained in the pulp, which is concentrated and used in the manufacture of citric acid, and the residue, after the final extraction of the oil and juice, is used as a cattle-food. The oil is always known in commerce as essence of Bergamot, and is imported chiefly from Messina and Palermo. Its principal use is in perfumery. Like all other fruits of the orange tribe the Bergamot has its varieties with fruits of singular formation. One, for instance, in which the fruit is flattened to where there is a circular opening, discloses a number of irregular prominences. On cutting one of these fruits across a series of about twenty cells filled with pulp are seen around the circumference, and in the center a number of cells agreeing with the external prominences.

Lime (*Citrus Limetta*, Risso). The chief use of the Lime is for the juice, which has a great reputation as an antiscorbutic; several varieties are cultivated.

Shaddock (*Citrus decumana L.*). The fruits of the Shaddock are known under distinct names, according to their size; thus, a full grown fruit is very large and weighs from 10 to 20 pounds; they are then called Pompelmousses or Pampelmousses, while those of the smallest size are known as Forbidden Fruit or Pomeloes.

Citrus Japonica (Hib.) is a native of Japan, the fruits of which are about the size of a large cherry and quite spherical, with a thin rind, and a very sweet, agreeable pulp.

It is known as the Kumquat, and the fruits preserved in sirup are often exported from that country.

From notes relating to the preparation, and the commercial aspects, of the productions of the Citrus family it is remarked that of all scent-yielding plants none has a value at all equal to that of the Citrus tribe. The orange is a mine of perfume in itself. The blossoms yield, according to their mode of treatment, two distinct odors, one having the true scent of the flower, the other a scent called neroly. Orange-peel, too, furnishes a delightful perfume, and the leaves give a scent inferior only to the true neroly. Orange stocks are raised from seeds or pips, and in the third year they are grafted. In the fifth year they are planted where they are to stand. The soil should be well prepared, inasmuch as fifty years, nay, even a century afterward, the results of good early treatment will be apparent.

Orange-trees require from ten to fifteen years to reach a good size, but they will produce both flowers and fruit in four or five years. When in full vigor, each tree yields on an average 25 pounds weight of blossoms annually. At Nice a public market exists for the sale of orange-blossoms during the season when the trees are in bloom. The bitter-orange flowers bring six cents per pound; those of the sweet orange four cents. A ton of flowers will, by means of distillation, yield, say, 40 ounces of neroly otto, worth $120, and the residuary water—orange-flower water—about $25. Orange-flower fat, or butter, and oil are manufactured to a large extent by the enfleurage and macerative process. It requires about eight pounds of blossoms to enflower one pound of grease, the operation being divided into about thirty repetitions of a small quantity of flowers over or in the same grease. By digesting this orange-flower grease in the proportion of six pounds to eight pounds in one gallon of rectified alcohol, there are obtained the extracts of orange-flowers, a handkerchief-perfume which is surpassed by no other scent.

The *Citrus bergamia*, or bergamot lemon, is a plant of great value as a scent-yielder; its perfume is so much in demand that its annual production in Italy has never satisfied the market. The Messina dealers and their allies carefully adulterate the true bergamot-otto with lemon-otto. The name of this variety is derived from the city of Bergamo, in Lombardy, from whence the otto was first sold. The otto of bergamot of the finest quality is that which is expressed from the fruits; but about four-fifths of it in the market is a distilled product or one expressed from the rasped rind of the fruit. About 40,000 pounds weight of otto of bergamot are annually imported into England. In the little island of Montserrat the *Citrus limetta* grows most prolifically, and in almost an indigenous manner. One of the orange-orchards there consists of 500 acres, each acre containing 200 trees. They come into full bearing in seven years from the seed; they flower more or less whenever they get heavy rain, and the fruit ripens in about four months after the flowers appear. They fruit all the year round, but the chief harvest is from September to January. About 90,000 pounds weight of otto-lemon is imported into England. The otto of lemon in the market is principally from Messina, where there are hundreds of acres of lemon-groves, and the extraction of the ottos of lemon constitutes the chief industry of Sicily, particularly in the vicinity of Palermo. There is ample room in European markets for all that is produced here, as well as for all that may be produced in other countries.

The following remarks upon orange-growing in the Azores may also afford useful hints in this connection:

The culture of oranges has considerably increased during the last thirty years at St. Michaels. In former days the plants were left unsheltered; they were planted at great distances from one another, thus forming magnificent trees, covering a large surface of ground, one of which would bear from 15,000 to 20,000 oranges. A heavy stone was laid on the top of each tree to force the branches in a lateral direction and keep them low so that the wind might not destroy them. This system has been entirely abandoned, as it did not prevent the trees from being uprooted by the severe storms which blow from the Atlantic. The idea was then adopted of planting the orange-trees in small lots and surrounding them with trees of larger growths; but it was found that these overshadowed the oranges and prevented their ripening. In 1845 the system was introduced of inclosing the plantations by stone walls and with the best results. These walls are from 10 feet to 15 feet in height, inclosing spaces from 150 feet to 200 feet square. In the larger inclosures the average crop on each tree does not exceed 600 fruits, while in smaller spaces the average is from 2,000 to 3,000 fruits, showing how much good shelter and care will do towards increasing the crop. The ground of the plantations is well plowed and tilled for four or five years. After that it undergoes a superficial plowing twice a year, and is occasionally sown with a green crop, which is slightly covered in by shallow plowing. Every year the dead wood is cut out and the shoots thinned; but, as a rule, the orange-tree is never pruned. In dry seasons the ground is well watered if the supply be near and sufficient in quantity.

There are six principal varieties of sweet oranges cultivated in the Azores. The common one is of middle size, slightly acid, and very sweet-scented. The skin is thin and adheres well to the fruit, becoming a little thicker towards the end of the season. The *Comprida* is more aromatic than the preceding one, and also more acid. This tree is rarely loaded with fruit. Under the name of the Silver Orange is designated a much smaller one, with very firm flesh, extremely fine skin, and greenish-yellow color. The *Selecta*, or choice orange, is large, of first-rate flavor, little acidity, and of a deep yellow color. It has scarcely any pips, and does not ripen until April, which gives it a higher value. The Ombigo is flatter, and sweet, while it furnishes the largest crop of all. Finally comes the Mandarin, which differs little from the same variety grown in Malta. The fruit, as a rule, enters into its maturity in October, but the best varieties are not gathered until January, the season terminating in May. The trees are increased in a curious way. The mode of propagation was derived from the Chinese, and has been much in use of late years. A branch of the diameter of 4 or 5 inches is chosen, around which a circular incision is cut. Around this straw matting is wound in the shape of a funnel and filled with beaten earth from the middle of May to the middle of June. Roots soon begin to push, and by the following winter it is provided with sufficient to support it when detached from the parent stem.

The young plant thus obtained often bears fruit at the end of two or three years. Formerly grafting was employed, and is still used, but it is somewhat out of fashion, on account of the relative slowness with which trees "worked" by it come into bearing. It is, however, asserted that the trees to which it has been here applied give the best fruit, and last longer than the others.

The oranges are gathered with care and carried to the packing-shed, where each fruit is separately wrapped in a dry maize leaf, and put in the box. The shape of these boxes has been entirely changed of late years; formerly they held from 700 to 900 oranges. Thin flexible planks formed a convex covering, without any solidity, and containing in the lid almost as many oranges as in the box itself. This curious arrangement was explained by saying that the air circulated more freely between these planks, and that this was necessary to the preservation of the fruit; but really the custom arose from the wish to escape the tax imposed upon all exports, which only prescribed the dimensions of the lower part of the case. The growers made the box of the right size and then surmounted it with an enormous cover. Thus formed, they would not pack well and the fruits were crushed. The boxes are now made rectangular, divided into three compartments, are about a yard in length, and hold only half of what the former ones did. The expenses of gathering, carrying to town, storing, packing, embarking, including the case and maize leaves, amount to 65 cents a case. As for the price of a box of oranges, sometimes they are sold at St. Michaels, when just gathered, for $5 the 1,000, packing and transport being at the cost of the buyer; other times they have sold as low as $2. Of late years about 600,000 cases are yearly exported to England. Steamboats engaged in this service make eight voyages to England from the middle of November to the end of April; each carries about 5,000 cases.

THE PYRETHRUMS AS INSECT-DESTROYERS.

As information about the *Pyrethrums* is frequently sought by correspondents with a view to their cultivation and preparation for insecticides, the following notes collected on this subject are here introduced:

Several species of *Pyrethrum* have attained reputation as insect-destroyers. The *P. carneum* and *P. roseum* have both proved to be excellent in this respect. About 30 years ago the flowers of these were introduced in a powdered form under the name of "Persian Insect Powder." The flowers of *P. cinerariæfolium*, a native of Dalmatia, have been similarly employed under the name of "Dalmatian Insect Powder." A test of the value of these powders is thus described:

In order to test the effect of the different insect-powders, I sprinkled some flies with the powders, and took the length of the time required to kill the flies as the measure of the value of the powders. When a house-fly was placed in a small flask, sprinkled with four grains of insect-powder, if the powder was very powerful, there was considerable stupor at the end of one minute, followed by the death of the fly after two or three minutes. The commercial insect-powders behave differently in this respect; some of them corresponding completely to the above standard, while others, although they quickly stupefied flies treated as above, required fifteen to thirty minutes to kill them. My first test was made by some powder of my own preparation from the Dalmatian species. The druggists in Vienna purchase the whole flowers yielded by the uncultivated Dalmatian *Pyrethrum cinerariæ folium*, and the powder they supply is a very energetic preparation. It is noteworthy that both these entire flowers, and the powders prepared from them, after being kept six years, do not suffer any particular loss of activity. I have found the powder of the flowers of *P. cinerariæ folium* very active. *P. roseum* appeared to be slower in its action, which I ascribe to the circumstance that the single flowers are much more powerful than the double flowers, which appear to have little activity. The double flowers occur in *P. roseum* in much larger proportions than in *P. cinerariæ folium*, and to this fact I consider the greater activity of the latter due. The fresh (undried) flowers of both these *Pyrethrums* will kill flies, but very slowly. The plant itself, powdered, apperared to be quite inactive. In a similar manner I have tested the powdered flowers of several Austrian *Compositæ*, and I have found the following to be quite inactive in this respect: *Chrysanthemum leucanthemum*, *C. coronarium*, *Anthemis arvensis*, *A. cotula*, *A. tinctoria*, *A. nobilis*, and *Inula pulicaria*. The flowers of *Tanacetum vulgare* and *Pyrethrum corymbosum* appear to have a very slight stupefying effect. Of all the Austrian indigenous *Compositæ* tried, only the powdered flowers of *Pyrethrum parthenium* and *P. inodorum* exercised a stupefying influence upon flies, and that only after the flies had been dusted from one to two hours; their value, therefore, as insecticides is very slight.

In a scientific aspect it is, however, interesting to notice that up to the present time the action obnoxious to insects has only been observed in the genus *Pyrethrum*, while from other composites approaching very nearly to that genus the property is absent.

The seed of *Pyrethrum* are sown in spring; the plant is quite hardy, and blooms abundantly the second year from seed. The powder is made from the half-opened flowers, gathered during a dry day, and dried in the shade under cover. It is pulverized in a mortar, sifted and stored in bottles for use. It is largely cultivated in Russia, where it is used in immense quantities. An acre of ground in these plants will yield about 100 pounds of the powder. As it requires a considerable amount of labor and manipulation to gather, dry, and prepare the flowers, its culture is not considered profitable except in countries or localities where labor is very cheap and plentiful.

WITLOOF OR CHICORY.

Among the seeds lately distributed by the department, there were some packages of a new vegetable or salad plant, known as witloof, which has been the occasion of repeated inquiries as to its use and value.

The witloof—the literal meaning of which is "white leaf"—is a kind of chicory, which forms a close head of leaves very similar in habit to that of the upright headed, or *Cos lettuces*. The common chicory is a well-known roadside weed in many parts of the country, notwithstanding the roots are largely imported as a beverage material to mix with coffee, or to be used as a substitute for that berry. The slender roots of the chicory are much employed in France for forcing into growth in dark apartments, during winter, the delicate blanched leaves being used as a salad under the name of *Barbe du Capucine*. These leaves are quite bitter, and not agreeable to every one. The witloof variety, also called the large-rooted Brussels chicory, has a thick, stubby root, also much used as a coffee mixture, and is said to be the most profitable variety that is cultivated for that purpose. In Brussels, the leafy heads of the witloof are cooked whole and eaten with cream sauce, and in this mode it is much esteemed as a vegetable dish for the dinner-table. It is equally as good as a winter salad, and is less bitter than the common chicory when used for this purpose.

To grow the witloof properly requires a rich and deeply-worked soil, in which the seeds are sown in spring, and deposited in drills, which are about 18 inches apart, and as the young plants progress they are thinned out, so as to be about 4 inches from each other. They will have completed their growth by the end of October; they are then lifted with care, so as not to cut or bruise the principal root, the leaves cut back to a length of about 2 inches from the crown of the root, and stored in a warm cellar in the dark. The roots are set upright, a few inches apart, in light, rich soil of any kind, which may be secured by a liberal admixture of sand, leaf mold, or prepared compost, pressed firmly between the roots, and the tops will develop in time, according to the warmth of the room.

The temperature usually kept up in a greenhouse is well suited for its growth, and if planted in a dark inclosure, under the shelves or staging, a crop of leaves will be secured.

In Brussel, where the markets are supplied with this vegetable from Christmas till Easter, and later, the common practice is to store the roots thickly in beds, on a dry situation, in a field or garden. These beds are formed by digging out a shallow trench, from 8 to 12 inches below the surface, and 3 feet in width. In the bottom of this trench the roots are planted upright, or slightly inclined, at a distance of about 1 inch from one another, and in rows about 8 inches apart. Between the roots light soil or compost is placed and firmly pressed, so that no space may be left, and finally the surface is covered with 2 or 3 inches of the light soil, through which the young growths will push. The whole is then inclosed with a rude lattice frame, the top of which is elevated a foot above the plants; this prevents the covering material from pressing them. Fresh stable manure, to the thickness of 3 or 4 feet, is now put over the frame, completely inclosing the plants, the heat generated by the fermenting of the manure being sufficient to start the plants into growth; the progress of the inclosed vegetation being watched from time to time, the proper period for cutting the crop is readily ascertained.

SESAMUM INDICUM.

Among oil-yielding plants the sesame plant is frequently referred to. Some correspondents allude to it as furnishing ben-oil, or the oil of ben. This mistake no doubt originates from the common name of the leaves of the *Sesamum*, which are sometimes called benne leaves. The true oil of ben is prepared from the seeds of *Moringa pterygosperma*, which are called ben-nuts, and yield a peculiar kind of fluid oil, in the East Indies. This oil is reputed for its value for watches, and is more of a novelty than it is an article of commerce anywhere; on the contrary, the *Sesamum* is one of the valuable oil-yielding plants of the world.

The sesame is an annual herb, a native of the East Indies, but widely cultivated in tropical and semi-tropical climates throughout the world, for the sake of the oil contained in its seeds and other uses to which the latter are applied.

There are two varieties in cultivation, the white-seeded and the black-seeded; the black-seeded is said to be the best oil-producing variety, although the difference between the two kinds is not considered to be of any great moment.

Its cultivation is of the most simple kind. It is sown thinly in drills, after the soil becomes warm in spring, and the stems are collected and dried when the seed is ripe. The seeds are thrashed out in the ordinary manner adopted for rape-seed and similar products.

The oil is known as gingelly or sesame oil. The best quality is obtained by first washing the black seeds in cold water, or boiling them for a short time until the reddish coloring matter of the skin is removed and the seeds have become white. They are then dried in the sun, after which the oil is expressed. The seeds contain about 40 per cent. of oil.

Sesamum-oil is insoluble in alcohol, readily saponifies with alkalies, and combines with the oxide of lead. For all purposes of medicine and pharmacy it is considered equal to the best olive-oil. It will keep for many years without becoming rancid either in smell or taste, and is said to be largely used in increasing the amount of the olive-oil of commerce. In Japan it is used for cookery purposes, and is preferred to all others as a salad-oil. It is sufficiently free from smell to admit of being made the medium of extracting the perfume of the jasmine, tuberose, the orange, and other fragrant flowers for purposes of perfumery. It is used medicinally as a laxative, and is preferred by some to castor-oil.

The cake, after expression, mixed with honey and preserved citron, is esteemed an Oriental luxury, and the roasted seeds are used as a substitute for coffee. The cake, after pressure, is also employed as a food for bees. The plant has long been cultivated to some extent in the Southern States, yielding an abundance of oil of the best quality; and it could be produced in any quantities that commerce might demand or farming profits justify.

The leaves of the *Sesamum*, under the name of benne leaves, are valued for their mucilaginous properties; two or three of the fresh leaves are soaked in a tumbler of water. Administered repeatedly, this gummy water is a popular domestic prescription for some complaints in children.

ARACHIS HYPOGÆA.

The ground-nut, or pea-nut, may also be mentioned in connection with oil-bearing plants. The seeds are among the best known as oil-producers, yielding from 40 to 45 per cent. of oil, which is not inferior to that obtained from the olive as regards quality, and is good for every purpose for which olive-oil is used. It is a good lamp-oil, burning with little smoke, a clear flame, and affords a very full, bright light. It is one of the best lubricating oils for machinery; and for all alimentary purposes it is equal to the best olive-oil, and it is said to be largely substituted for that article in commerce. Many thousands of tons of the nuts are annually imported into France for the purpose of expressing the oil, which, it is stated, finds its way into the trade under the name of olive-oil, which can scarcely be called an adulteration, as the pea-nut-oil possesses a sweetness and delicacy not easily surpassed. The ground-nut is grown in immense quantities in the East India Islands and along the African coast, mainly for the sake of its oil. In Java and Malacca it is known as katjang-oil. Another use made of the nuts (which is said to be increasing) is that of grinding them up for mixing with cacao in the preparation of chocolate, and it is freely asserted that in the manufacture of the latter, where the ground-nut is easily procured, the cacoa is entirely omitted in the preparation of so-called chocolate condiments.

MADIA SATIVA.

This plant is found in California, Oregon, and other parts of the States bordering on the Pacific, where it sometimes is called tar-weed. In Chili, where it is also a native, it is cultivated for the sake of the oil which is expressed from the seeds. This oil is used as a salad-oil, and, indeed, for all purposes to which olive-oil is applicable. It has been introduced and cultivated both in European and Asiatic countries as an oil-producing plant, and it is stated that the produce per acre is about the same as that yielded by rape and poppy seeds.

To those who are interested in oil-producing plants, the following table, quoted from Boussingault, shows the results of some experiments made by M. Gauzac, of Dagny. All of the plants mentioned can be matured in any climate where Indian corn will ripen.

Names of plants.	Seeds produced per acre.			Oil obtained per acre.		Oil.	Cake.
	Cwt.	*qrs.*	*lbs.*	*Lbs.*	*ozs.*	*Per cent.*	*Per cent.*
Colewort	19	0	15	875	4	40	54
Rocket	15	1	3	320	8	18	73
Winter rape	16	2	18	641	6	33	62
Swedish turnips	15	1	25	595	8	33	62
Curled colewort	16	2	18	641	6	33	62
Turnip-cabbage	13	3	19	565	4	33	61
Gold of pleasure	17	1	16	545	8	27	72
Sunflower	15	3	14	275	0	15	80
Flax	15	1	25	385	0	22	69
White poppy	10	1	18	560	8	46	52
Hemp	7	3	21	229	0	25	70
Summer rape	11	3	17	412	5	30	65

JUTE.

The following remarks on jute and the plants which produce it have been prepared in accordance with inquiries on these subjects:

The plants furnishing jute have been cultivated by the natives of India for their own manufactures for many centuries. The word "jute" was originally used as a synonym for fiber, and is supposed to be the anglicized form of the Indian word *jhot*, which was formerly applied to vegetable fibers generally regardless of their origin; but the jute of commerce, at the present time, is yielded by two distinct species of plants belonging to the natural order *Tilliaceæ*, the *Corchorus olitorius*, and *Corchorus capsularis.*

These two species are similar in general appearance, shape of leaves, color of flowers, and habits of growth, differing only in the formation of their seed-pods; those of the *C. capsularis* being short, globular, and wrinkled, while those of *C. olitorius* are about the thickness of a quill, and about two inches in length. Both plants are annual, and grow from 6 to 16 feet or more in height, average of crops being about 10 feet high, with stems from one-half inch to one and one-half inches in thickness, seldom sending out side branches except near the top.

Each of these species has a white and a reddish variety; the stalks and leaves of the first-named being of a light green color, whereas in the second-named variety the stalks are red and the leaves red-veined.

The leaves of both these species are used as pot-herbs and as an ingredient in soups. *C. olitorius* is largely grown about Aleppo as a pot-herb, the Jews boiling the leaves to eat with their meat; hence the plant is oftentimes called Jews' mallow.

An infusion of the dried leaves is used as a tonic bitter; and medicinally they hold an important place in the East Indian native pharmacopœia.

The roots of the plants are used in the manufacture of paper; an oil for burning is extracted from the seed, but it yields so small a quantity of oil that the plants cannot be ranked among those profitable for their oil-bearing qualities, and the cake left after expression is not nutritious as food for live stock.

The *Corchorus capsularis* is the species principally cultivated in the central and eastern districts of Lower Bengal; but the *Corchorus olitorius* is more largely grown in the districts near Calcutta, and from its fiber is manufactured the well-known Luckhipore jute of Hooghly, which also goes by the name of *Desi* jute. There is no difference in the quality of the fibers produced by these two species, but in commerce marked differences are noticed in the productions of different places; these differences are attributed to climate, soil, time of cutting and methods of preparation of the fiber.

The best variety is called *Uttariya*, which is said to possess to the greatest extent those properties which are essentially necessary in fiber intended for spinning, namely, length, color, and strength; this is understood to be produced by the white varieties of *Corchorus*. The next in quality is called *Deswal*, which is esteemed in commerce on account of its fineness, softness, bright color, and strength; this is said to be produced by *C. capsularis*. The *Desi* has a long fine, and soft fiber, and is mainly produced by *C. olitorius*. The *Deora* is much used for the manufacture of ropes; it is strong, coarse, and black; this derives its name from a locality.

The best *Uttariya* jute usually brings 75 per cent. more in market than other kinds. The time of cutting, preparation before steeping, the length of time it remains in water, and the quality of the water, all seem to affect in a greater or lesser degree the value of the fiber. The best time for cutting is when the plant is in flower, and just before the first formation of seed-pods. The fiber from this cutting is of superior quality and of a fine glossy appearance. If cut earlier than this the fiber is very beautiful but lacks strength; if cut after the plants have fruited or seeded, the fiber is strong but harsh, wanting in gloss, mixed with bark, and woody in its general character, although the quantity is greater than is procured from the earlier cuttings. The later cuttings invariably produce fiber of a dark or grayish color.

After cutting, the stalks are left to stand in the field for a couple of days to allow some of the juices to evaporate. When so treated the stalks rot more quickly, and the fiber is not injured, as too much steeping impairs its value; steeping in water for fifteen to twenty days will then prepare it for manufacture. Too much steeping, as also using dirty water, will make the fiber of a dirty, dark color.

How far the cultivation and preparation of this fiber for the manufacturer may be profitable remains to be seen. With such improved methods and processes of handling and preparing for market as experience will speedily mature, the grower will doubtless find it a profitable crop; but unless the machinery for manufacture be ample and of the most improved kinds, the profits of manufacture may not prove very attractive. The following remarks on the jute industry in Bengal as it was several years ago, are instructive in this connection:

The manufacture of gunny-bags employs all classes, and penetrates into every household. Men, women, and children find occupation therein. Boatmen in their spare moments, husbandmen, palankeen-carriers, and domestic servants, everybody, in fact, being Hindoos (for Mussulmen spin cotton only), pass their leisure moments, distaff in hand, spinning gunny twist. Its preparation, together with the weaving into lengths, form the never-failing resource of that most humble, patient, and despised of created beings, the Hindoo widow; this manufacture spares her from being a charge on her family; she can always earn her bread. There is, perhaps, no other article so universally diffused over the globe as the Indian gunny-bag. All the finer and long-stapled jute is reserved for the export trade, the short staple serves for the local manufactures, and it may be remarked that a given weight of gunny-bags may be purchased at about the same price as a similar weight of raw material, leaving no apparent margin of profit for spinning and weaving. The gunny-bag or cloth is sent from Calcutta to Penang, Singapore, Batavia, and the whole of the Indian Archipelago, for packing pepper, coffee, sugar, &c.; to the west coast of America for nitrate of soda, borate of lime, regulus of silver, &c.; to the Brazils for coffee and cotton, and to the United States for packing cotton. Thus it finds its way to Liverpool, London, and other European ports, and is sold to the wholesale dealer with the sugar, coffee, pepper, and cotton. When again disposed to retail merchants in the country, the bags are purchased for making mats, and these mats are widely sold and distributed all over the country. There are people who make a good trade even by buying up the bags that have held the sugar, and selling them again to the ginger-beer or "pop" manufacturers, who first boil them to get out all the saccharine matter to sweeten this popular beverage, and then dispose of the bags to the mat-makers.

Respectfully submitted.

WILLIAM SAUNDERS,
Superintendent of Gardens and Grounds.

To Hon. WM. G. LE DUC,
Commissioner of Agriculture.

REPORT OF THE CHEMIST.

SIR: The work of the Chemical Division of the department prosecuted during the past year consists of—

1. Analysis of lime marls.
2. Examination of soils.
3. Analysis of bat guano from near Galveston, Tex.
4. Analysis of sugar from the early amber sugar cane.
5. Estimations of sugar in various beets sent to the department.
6. Examination and report of an experiment in beet culture made on Batsto farm in Atlantic County, N. J.
7. Experiments to determine the presence or absence of the so-called peptone forming ferment in the roots of plants.
8. Investigation of American sumac, to determine—
   A. At what time during the season the spontaneous growth of our country should be collected in order to secure the highest possible proportion of tannic acid in the product.
   B. The causes producing the difference in the market values of the American and Sicilian products.
   C. A practical method for obviating these causes.
9. Investigation of the physical and chemical causes tending to the production of mildew and rot.

Besides the work here indicated, a large amount of unimportant qualitative work, requiring a great deal of time, has been attended to.

The work of analysis and of regular investigation has also been seriously interfered with by the requirements of correspondence and consultation.

1. The examination of marls has been confined to those having carbonate of lime as a basis, principally the shell-marls of the Tertiary formations.

As will be seen, the value of these marls depends entirely upon the carbonate of lime they contain, for they seldom if ever contain any appreciable quantity of other valuable constituents.

The percentages of phosphoric or potash seldom reach half of one per cent., and in the majority of cases only traces of them are found.

The shell-marls are valuable for direct application only when the shells, exposed to atmospheric influences, readily disintegrate and fall to powder, and the sedimentary lime marls, like those of Florida, are valuable only when the carbonate of lime is present in a finely-divided condition. In all cases in which they are at all rocky and fail to disintegrate when exposed, they should be burned previous to application. But that of Mr. Whitner, noticed below, would not be worth the trouble and expense involved.

The same is true of the shell marls. To be worth burning, they should contain at least 50 per cent. of shells of carbonate of lime, and even then it is questionable whether the work would prove profitable. Indeed, analysis of these Tertiary marls heretofore made in the department show their value to be very low, and the present analysis is seen to confirm the former conclusions with regard to them.

The following table indicates the results of the analysis made:

	I.	II.	III.	IV.
Lime	10.8866	12.9155	11.924	10.831
Phosphoric acid	0.4822	Trace	0.421	....
Potash	Trace	0.0381	....	....
Insoluble matter	32.93	53.3271	....	....
Undetermined	55.7021	33.7193	87.655	....

Samples Nos. I and II were presented for analysis by Mr. J. J. Shannon, Meridian, Miss.; No. III by W. R. Carter, Beebe, Ark. These were all shell-marls. No. IV was sent by Mr. B. F. Whitner, Fort Reed, Fla. The soil examined was also sent by Mr. Whitner. He states that where this soil prevails orange trees die after two or three years, and it is consequently denominated "die-back" soil. Careful qualitative examination failed to reveal the presence of any poisonous quality. It is impossible, without a thorough examination of the character of the subsoil and the surroundings, to positively assign any reason for this influence upon the orange trees, but it is probable that judicious applications of lime, the phosphates, and potash salts will be effective in removing the troublesome cause. The sample of soil presented was sand, and contained a small proportion of organic matter.

3. The statements made in the last annual report concerning the value of the bat guanos of the South have received further confirmation in the results of an analysis of a sample received from Mr. A. H. Kent, of Galveston, Tex.

These deposits are probably far more numerous than may be expected from the reports received at the department, but the samples already analyzed represent a value aggregating nearly $20,000,000. The mechanical condition of the material is excellent for ready application, and it will be found exceedingly valuable as a fertilizer for corn or tobacco, or, indeed, for any crop whatever.

The composition of the sample from Galveston is indicated in the following statement of analysis:

Organic and volatile constituents		86.300
Water	2.106	
Ammonia (actual)	2.267	
Organic nitrogen (representing of ammonia NH_3, 5.045)	4.155	
Undetermined	77.772	
Ash constituents		13.700
Lime	3.806	
Potassa	1.692	
Soda	0.146	
Phosphoric acid (in form of $Fe_2O_3PO_5$, 0.362)	1.173	
Insoluble matter	0.912	
Undetermined	5.431	
	100.000	0100.00

According to the generally accepted commercial values of the various important constituents, the guano represented by the sample analyzed, if of quality uniform with it, would be worth about fifty dollars per ton of two thousand pounds. We regret that no description of the locality or extent of the deposit was given in the letter accompanying the sample, for such a description would be not only of interest but of value also.

4. Some time ago a sample of sugar made from the Early Amber sugar-cane was submitted for analysis. It has been made by merely expressing the juice by crushing the cane between rollers, concentrating in open pans to a consistency fit for crystallization, and filtering through coarse gunny-bags. The sugar thus obtained has the percentage composition indicated below:

Cane-sugar	88.8934
Grape sugar (glucose)	5.6100
Water (expelled at 110° C.)	5.8250
	100.3284

This shows the importance of the further study of the sorghum as a source of cane-sugar. If a product as good as that analyzed can be obtained in the rude and comparatively imperfect method described, it is reasonable to suppose that with the application of the most approved methods the extraction of sugar from this source will be attended with profit.

5. The great value of the sugar industries, and the interest lately aroused, caused a number of beets to be sent to the department for examination. Some of these were the sugar-beets, while others were merely mangolds. Unfortunately none of the specimens sent were accompanied with any information concerning the methods of cultivation or the fertilizers used, if any were employed. All were analyzed, however, and the results of some of the analyses show the capability of our cultivators to raise good beets for sugar manufacture; and if the present interest in the matter can be maintained, there appears to be no reason for failure to establish the industry in the Eastern States as successfully as it has already been established in California.* To attain this success, however, great attention must be paid to preparation of the soil, the character and composition of the fertilizers used, and the methods of cultivation adopted. These are facts that cannot be too frequently repeated.

The following table shows the results obtained by the analysis:

Origin.	Variety.	Date received.	Number of roots tested.	Mean weight of root.	Percentage— Of root available.	Of juice in root.	Of sugar in juice.	Of impurities in juice.
T. J. Beans, Morristown, N. J.		Oct. 31	3	1,018 grams / 3.34 lbs	76.55	69.02	7.75	1.875
B. W. Payne, Corning, N. Y.*	Imperial	Dec. 1	1	1,508 grams / 3.316 lbs	84.15	60.77	9.38	1.68
Do†	White Sicilian	Dec. 1	2	830 grams / 1.82 lbs		60.15	10.18	1.75
J. J. Toon, Smyrna, Ga	Mangold-wurzel		½			81.24	2.11	6.76
W. D. Lane, Middlebury, Vt	Lane beet			977 grams / 2.149 lbs	74.0	51.12	4.72	3.66
Do	Red beet			1,357 grams / 2.985 lbs	88.58	58.05	6.10	3.40

*No. I. †No. II; raised at Elmira, New York.

*From information later received, it appears that the industry was a complete failure last year on account of the continued dry weather.

The beets sent by Mr. Thomas J. Beans and Mr. D. W. Payne represent crops that can undoubtedly be worked up for sugar with profit, and it is satisfactory to know that both these gentlemen are making active preparations for the cultivation of larger crops during the coming year.

6. But the most important and most satisfactory experiment in beet culture that has come under the notice of the Chemical Division, is that made at Batsto farm, in Atlantic County, New Jersey, by Mr. Joseph Wharton, of Camden, N. J. Mr. Wharton has purchased a large tract of land there, and last spring decided to devote a small portion of it to the experiment of raising beets and extracting the sugar from them on the farm. It was not his purpose, as will appear below, to produce crystallized sugar directly, but to concentrate the juice to sirup and send it in this form to the rectifiers for purification and crystallization.

In response to an invitation from Mr. Wharton, and in compliance with your instructions, I proceeded to Batsto farm and "examined as thoroughly as possible into the soil, seed, culture, quality of the product, mode of harvesting, and cost of beets delivered at the mill; also the manner of extracting the juice, arrangement and cost of machinery for reducing the juice to sirup or sugar, and the quality of the product." From the fact that the records of the experiment were not closely kept, and from various other reasonable causes, the results of my inquiries were not altogether satisfactory. Mr. Wharton's letter, which will be found below, explains the objects he had in view in making the experiment. It shall be my purpose in the following page to describe the experiment, and suggest modifications that I consider would be of value in future work:

CAMDEN, N. J., *December* 4, 1877.

DEAR SIR: When inviting you and other gentlemen to visit Batsto, I was perfectly aware of the crudity of my operations there, yet thought it might instruct you and them to see this serious though imperfect attempt at sirup-making from beets. I consider the result attained is so far valuable that it demonstrates the possibility of raising upon Jersey lands beets with a fair percentage of sugar, and further, the possibility of putting that sugar into salable condition as crude sirup by means of quite simple apparatus capable of being operated by intelligent farm-hands. No doubt a great obstacle in the minds of American farmers to the raising of sugar-beets has been the belief that a large and complicated establishment for the working up of the beets was indispensable to successful beet culture. My experiment has, I think, proved that beet juice, defecated with lime and heat and boiled down in an open pan, is fit for delivery to refiners, and is consequently salable. Probably neither the outlay for establishment nor the skill required would greatly, if at all, exceed that needed for a cheese factory. Quite possibly the joint efforts of a farming neighborhood may hereafter, in many places, establish beet-sirup houses as they have already established cheese factories. Of course the primary results of this first experiment of mine are very bad indeed; until great advances have been made and much larger crops are to be handled, loss must result.

Yours, truly,

JOSEPH WHARTON.

Hon. WM. G. LE DUC,
Commissioner of Agriculture.

The soil on which the crop was grown is merely loose, siliceous sand, with no apparent fertility, the surface soil containing a small quantity of organic matter, and in some cases a slight admixture of gravel. It is 8 inches deep, and is underlaid by a subsoil of yellow, ferruginous sand. It is sufficiently loose and pliable to need no pulverization, and the only preparation it received was a single plowing in April. It was then, without either harrowing or rolling, marked out in ridges, by making a furrow which was filled with manure and covered by throwing two furrows together over it. In the application of the manures, the lot on which those first planted were grown, and consisting of ten acres, was divided, longitudinally, into five sections, which were fertilized after the manner and with the quantities indicated in the following diagram:

5	300 fish	lbs. guano,	an	1 d m	0 tons uck.						
4		kai	500 nit	lbs. alo	ne.						
3	300 fish	lbs. guano.	10 m	tons uck.	500 kai	lbs. nit.		Portion of field planted with seed from Antwerp.	Barn-yard manure, and muck.		
2	300 fish	lbs. guano,		10 tons muck.							
1	300 fish	lbs. guano.	8 t ma	ons rl.	4 or stable	5 tons manure					
	April 26	30	May 4	7	9	11	14	18	19	21	22

NOTE.—The remainder of the field was planted late in May, with seed obtained from abroad, but no attention was given to it, from the fact that the planting was too late, and the crop on that part failed completely. The seeds planted previous and up to May 14 were Vilmorins' White Silesian, bought from several dealers in Philadelphia. Those planted later were also White Silesian, imported from Antwerp. They were all soaked in cold water overnight, and then sown in rows about 2½ feet apart, crossing the field laterally. They were sown at different dates, as indicated in the lower row of the diagram. At first it was determined to plant about 4 pounds of seed per are, but this amount was subsequently increased to 10 pounds per acre. They were put into the ground to a depth of 1½ to 2 inches, by means of a hand-drill, which failed to deliver regularly, making a necessity for a great deal of subsequent transplanting, which, as is well known among beet-growers, is unsatisfactory, and is very unfavorable to the production of good beets. As a consequence, in this case there were very many bare spots in the field.

The cultivation of the crop on the light sandy soil of Batsto farm was not very difficult, and was effected by five applications during the season of the cultivator, followed by hoeing and hand-weeding. This process was rendered more troublesome and costly by the fact that during the five previous years the land had not been under any cultivation; was not in grass, and was, as a consequence, covered with weeds. The work of cultivating future crops will, therefore, be less costly. The crop was harvested about the 1st of November, no mechanical appliance being used, or indeed being necessary, for raising them, on account of the very loose and mellow condition of the soil. They were, therefore, pulled by hand, and stored for the short time required for this crop by piling them in heaps, with the roots toward the center, in such a manner that they would be covered by leaves, and thus protected from the influence of desiccation and frost. The quantity placed in each heap was never allowed to exceed ten tons, including the leaves and tops, on account of the possibilities of fermentation and heating.

From these heaps the roots were carried to a convenient place near the mill, where the tops and leaves were removed by means of a knife sufficiently heavy to enable the boy using it to effect the removal at a single blow. The dirt adhering to the roots was then carefully removed by means of a washing apparatus. The nature of the soil admits of a very complete cleansing of the roots by very simple means, since the light sand falls off readily in water without any such scouring as would be needed to remove a sticky loam, and the apparatus employed therefore merely consists of a cylinder, 4½ feet long and 2 feet in diameter, hung upon an axis, to an extension of one end of which a crank is attached, enabling the workman in charge to turn it.

The cylinder is made up of wooden strips 1 inch square, attached longitudinally, with sufficient space between them to admit of a free play of water, and is placed in a cistern provided with a constant water-supply and overflow. The beets are passed in at one end, and, after a few revolutions of the cylinder, are taken out at the other end. To facilitate their removal, a triangular platform or partition is arranged at the end nearest the workman, that takes up a few beets with each revolution, which may then be taken off by hand. The beets, after having been thoroughly washed in this apparatus, are passed to the mill, which has been arranged in a building formerly used for a flouring-mill, and which was devoted temporarily to the experiment of the manufacture of beet-sugar. It contains three floors, upon which the apparatus was arranged in the manner indicated below. The washed beets as delivered to the mill are first reduced to pulp by means of a very efficient rasp, which is one of the best made abroad. It is provided at the top with a hopper, to the bottom of which are two plungers that work to and fro horizontally by a motion communicated by eccentric cog-wheels. These plungers force the beets that are fed to the machine against the cutting cylinder, which is furnished with saw-teeth. It revolves at the rate of about 800 times per minute, and is capable of reducing to pomace about 100 tons of beets per day. The pulp from the rasp is almost immediately passed to a press, consisting of a centrifugal filter, capable of receiving a charge of 150 pounds, and of revolving when in action at the rate of 900 times per minute. The action of the filter upon the pulp is continued about fifteen minutes, until most of the juice has been removed, when the pulp is washed with water, in quantity amounting to about 37 per cent. of the volume of the juice. By this means about 60 per cent. of juice is extracted, leaving 40 per cent. of the original weight of the pomace in the condition of a moderately dry pulp, fit for feeding the cattle.

After every fifth charge of the centrifugal machine, or at intervals of about two and one-half hours, the collected juice and washings, which generally amount to about 85 gallons or 700 pounds, are pumped to the upper floor of the building, where it is placed in the defecating-tubs and heated by means of a coil of steam-pipes to 90° or 95° C. (195° or 200° F.). When this temperature is reached, about six pounds of lime are added, and the temperature raised to about the boiling point, which is maintained until perfect defecation is accomplished.

The juice is then drawn off and passed through bag-filters, to separate the impurities and much of the scum that may accompany it. The scum remaining after drawing off the defecated liquor is subsequently placed in bags and submitted to pressure in order to remove from it any adhering juice. It is then preserved to be employed as a fertilizer, for which purpose it is quite valuable on account of the considerable proportion of phosphoric acid, nitrogen, and salt it contains.

The filtered juice, which is of a clear amber color, is passed to the concentrators, which are cast-iron sugar-pans, holding 120 gallons each, and provided inside with coils of iron pipe of 2 inches diameter, through which steam of forty-five pounds pressure is passed. Sulphuric acid is added to the juice in the concentrators until the lime, added in the defecating-tubs, and not entirely removed with the impurities, is completely neutralized.

The concentration is then continued until a density of 32° Baumé is attained. The resulting sirup is then filtered through bags and packed in hogsheads ready for sending to the molasses-refiners for the extraction of the sugar.

The value of the sirup is estimated at about 30 cents per gallon, and by polarization, it is found to contain from 46 to 52 per cent. of sugar.

The refuse, consisting of the tops, leaves, and pulp, is, after admixture with salt, buried in trenches and preserved for cattle-food, for which purpose it is exceedingly valuable, the tops and leaves being estimated at $3 and the pulp at $5 per ton.

With regard to the total cost of the machinery no exact data could be given, because the account had not yet been made up, but it is expected to aggregate about $2,000. The same difficulty exists with regard to labor, &c., and for cultivating and handling the crop. The work of extracting the sugar required, besides that of the superintendent, the services of five men and one boy during the day, and of four men during the night, at an average cost of $1 per day for each.

The following communication concerning the quantity and quality of the crop has been received from Mr. Wharton:

Dear Sir: Mr. Humphrey, superintendent, now reports that the weight of topped and dressed beet-roots treated at Batsto was 30.7 tons, yielding 11.8 tons pulp, 10 tons leaves and tops. The roots so prepared contained—

	Per cent.
Sugar	7.9
Impurities	2.6
	10.5

Coefficient of value, 74.

The product was three parcels of sirup, about 150 gallons each, having the composition stated below. No. 1 was passed through bone-black before boiling down. Nos. 2 and 3 were not, but simply defecated and boiled.

	No. 1.	No. 2.	No. 3.
Sugar	48.9	45.9	47.9
Glucose	0.0	0.0	0.0
Ash	3.0	4.5	5.0
Organic impurities	8.4	4.6	13.1
Water	40.0	35.0	34.0
	100.9	100.0	100.0

Estimated value of sirup by molasses dealers is from 30 to 35 cents per gallon.

Yours, truly,

JOSEPH WHARTON.

Hon. Wm. G. Le Duc,
Commissioner of Agriculture.

While at Batsto I secured samples of the beets, defecated juice, and sirup for estimation of their values, and have found them to contain respectively, of valuable constituents, the quantities indicated in the following tables:

A.—BEETS.

	Number of roots.	Mean weight of roots.	Percentage— Of root available.	Of juice in root.	Of sugar in juice.	Of impurity in juice.
		Lbs.				
Sample No. 1	6	1.135	79.40	65.14	10.63	1.46
Sample No. 2	7	1.208	83.72	65.79	8.67	2.425

B.—CLARIFIED JUICE AND SIRUPS.

	Percentage of sugar.	Percentage of impurities.
Clarified juice	4.44	1.686
Sirup concentrated without filtering through bone-black	51.48	13.675
Sirup concentrated after filtering through bone-black	49.28	16.093

The experiment was not a financial success, nor was it expected by its projector that it would be, as will appear from the appended note from Mr. Joseph Wharton,* the intelligent and energetic proprietor of the farm, but it proved that beets of fair quality could be raised on the soil of that section. The soil is, it is true, poor and thin, but if it contains but little that is of value for plant-food, it also contains little that may exert an injurious influence upon the quality of the beets grown, so that the latter may be better governed here by the application of fertilizers, and only those need be applied that will increase the sugar contents without increasing the size of the beet or the impurities in the juice. All these are important considerations in the profitable cultivation of this valuable crop. In the present experiment, the rules adopted by beet-growers abroad, and proven by careful experiments made both in this country and in Europe to be most favorable to the growth of a product of the best quality, were not strictly adhered to. For instance, we find that on part of the field barn-yard manure was applied immediately preceding the planting. According to the adopted rules, however, this should be applied to the previous crop, or should be applied in the fall and plowed in deep, and even then it should be thoroughly well rotted previous to application. Again, we notice generous applications of fish-guano. Both the materials mentioned are highly nitrogenous, a quality fully proven to have an injurious influence by increasing the size of the beet and the impurities. It is but fair, however, to remark that Mr. Wharton, who is well aware of these facts, did not decide until last spring to plant beets, and he was therefore limited to spring-manuring with such fertilizers as were obtainable upon a farm which had long been utterly neglected, or nearly so. We notice the application of kainit or crude chloride of potassium.

*As to the question of profit and loss, the balance on the side of loss is so great as to seem quite absurd, and I have no hope of any sign of profit appearing until after years of patient toil and careful endeavor, if at all. There lies just the question I should like to solve, viz: whether, supposing all necessary skill, diligence, and capital to be applied, profit can at last be attained.

Yours, truly,

JOSEPH WHARTON.

There is no objection to the use of potash-salts, but Prof. Charles A. Goessman has established the fact that sulphate of potassium is the better potash compound to apply for the production of high sugar percentages. We find in our diagram indications of the application of no phosphates other than those contained in the marl and the fish-guano, yet we know that they have an exceedingly favorable influence, and often to such an extent that many foreign beet-growers use them (upon soils much richer, of course, than that of South Jersey) to the exclusion of all other fertilizers, the potash-salts included. Lime, if composted with the muck that can be obtained without difficulty in that region, would have a beneficial effect. Indeed, it might be used, in this connection, by following Prof. George H. Cook's suggestion with relation to its admixture with the greensand marls, with a view to the liberation of the potash they contain. The marl and lime could be mixed, and in order to facilitate the oxidation of the iron compounds of the marl, a small quantity of niter or salt could be added. After weathering, the whole might be composted with the muck, thus forming a good fertilizer of home production, which, together with some commercial phosphates, would furnish all that the crop would require.* We noticed, while at Batsto, the field prepared for a crop for next year. It had had no application of barn-yard or other manure, because there was none made upon the place and none could be bought in the neighborhood, and for this I would suggest the lime, marl, and muck compost, with an application of phosphate of lime in the spring. Marl thus treated would furnish potash sufficient, in connection with the lime, to satisfy the demands of the crop. A small quantity of sulphate of potassium might be applied with the phosphate, and by following such a course I firmly believe that a crop could be secured that would contain, instead of 8 to 10 per cent. of sugar, 12 or 14 per cent., and this, too, with a decreased percentage of impurities.

The climate of that section is good,† and the physical condition of the soil is good, so that the matter of raising good beets will depend upon the fertilizers, and if the acknowledged rules relating to this part of the business are followed, there is good reason to hope that the crops may be good also.

With regard to the method of extracting the juice, it appeared to me while there that it would have been better to combine, to a certain extent, the diffusion process with the use of the press, in order to secure economy of time in working and fuel in evaporating. Thus, if, instead of using for washing the pulp a volume of water equal to 37 per cent. of that of the juice, the pulp, before pressing, were mixed with about 15 per cent. of water, as recommended by Roberts, and, after two or three hours' standing, pressed out in the filter, and the pulp washed with about 5 per cent. volume of water, we would have a saving of at least 15 per cent. volume of water for subsequent evaporation. But this would necessarily be a matter for experiment, and, as suggested by Mr. Humphrey, might not effect sufficient saving to compensate for the increased space and apparatus that would be required. This is, however, one of the many minor points that must be determined by ex-

* The usual method of applying marl in the belt of farming region lying to the northwest of the sand district in which Batsto lies, is to mix marl with lime in this manner. About 15 to 20 per cent. of lime is considered sufficient. It is mixed while slaking with the marl, very much as a bed of mortar is made. This is the method I expect to follow.—W.

† The climate this year was very favorable in respect to rain-fall. It remains to be proven by experience of successive years whether the climate can be relied upon as habitually favorable to beets.—W.

perience, and Mr. Wharton says he is by no means sure that the centrifugal process will not be entirely thrown aside as soon as greater success in cultivation produces a crop large enough to warrant apparatus on a large scale.

INVESTIGATION TO DETERMINE THE PRESENCE OR ABSENCE OF THE SO-CALLED PEPTONE-FORMING FERMENT IN ROOTS.

The power of roots to act upon and render soluble the most refractory compounds in the soil, and the manner in which they absorb the nutritious materials which go to sustain the plant and provide the nourishment for its growth, in fact the function of the root in general has been written about, variously commented upon, and very carefully studied. Many investigators disbelieve in their power to render soluble any matters in the soil, and scout the idea of their having affinity for substances not readily soluble in water and the juices of the roots, and which are not capable of passing through the enveloping membranes by osmose and thus into the cell fluids, and in a similar manner throughout the entire plant. This class of thinkers and writers believe that all plant-food, in order to be available, must be in the form of inorganic compounds. Thus phosphoric acid can pass into the plant only as a soluble alkaline or earthy phosphate, nitrogen as ammonia or nitric acid, and carbon as carbonic acid. Later developments have, however, turned thoughts on the subject into another channel, and one which showed the possibility for many modifications of the accepted notions with relation to the function of the roots and their power over the elements of plant-food, whether inorganic or organic. I refer to the results of the able and interesting researches of Darwin and Hooker into the habits and actions of the insectivorous plants, and their power when having seized upon any body of a nitrogenous character, particularly albuminoids, to secrete the acid fluid capable of dissolving and placing at the disposal of the leaf on which it may have lodged for its own nourishment, and consequently that of the plant, the particle of food by a generous Providence or favorable breeze brought in its way. I refer also in this connection to the valuable investigations of Gorup-Besanez, who has carefully separated from this secreted fluid the active principle which constitutes the potency of this simple secretion, and also the success this investigator has been blessed with in his endeavor to separate the same principles from other plants and parts of plants, discovering its presence in seeds of vetch, hemp, and linseed, in germinated barley, and in kiln and air dried malt. If it exists in the seeds previous to germination and is found there after germination has taken place, its only function can have been that of rendering soluble and placing at the disposal of the youthful germ the nitrogenous substances of an organic character locked up in the insoluble compounds.

The careful observations of Darwin prove the capability of the plants to take within themselves and appropriate to themselves the matter made soluble by the secretions; and this is what takes place in the young plant evolving from the seed.

The principle referred to lay dormant during that condition in which freedom from acid reaction existed, but asserted its power when its potentiality was rendered active by the acid which always forms in the physical and chemical changes which the embryo must undergo before germination can take place. The question then arises, if the aërial portion of plants may secrete these acid substances that may prepare nutritive material for the nourishment of the plant, why may not this property also reside in the underground portions of the plant? If it exists in a dormant condition in the seed before germination, and becomes powerful in preparing the food for the young plant subsequent to germination, why should this same property not reside in the root after the nutritive material of the seed has been transferred to the plant and exhausted? The latter must depend for its existence upon the nourishment supplied through this underground organ, which has so many qualities and actions in common with the aërial portions, which have the power of reducing organic nitrogenous material to available plant-food without causing it to undergo veritable decomposition. Both are acid in their reaction; both are equally affected by heat and cold; both have the power to arrest and prevent putrefaction; and both are equally affected by substances poisonous to plants. Roots are known to have the power to remove from the water in which they grow the nitrogenous organic material existing therein as impurities, and this property has been considered due to the oxygen they exhale; but why is it not as reasonable to suppose that this purification is effected by the action of an acid secretion endowed with digestive power similar to or identical with that of the leaves of the insectivorous plants, which could prepare the impurities for direct absorption and assimilation? If roots are endowed with this power, then our notions of vegetable nutrition must surely be materially modified.

Instead of looking for complete decomposition of nitrogenous organic matters previous to absorption and assimilation, they may be rendered soluble by means of a secretion like that already described, and taken up directly in the same manner as the dissolved albuminoids are taken in by the leaves. For the purpose of determining whether or not this power is possessed by roots, and whether the peculiar ferment, as it is sometimes called, resides in them, experiments were instituted in this department and carried out in the manner and with the results detailed below.

In the first experiment wheat, barley, and oats were separately sown in boxes filled with sand containing considerable organic matter; but it was found exceedingly difficult, and, in fact, almost impossible, to separate the roots free from dirt without a great deal of manipulation—so much so, that the roots obtained were of little or no value for subsequent work. In order to avoid this difficulty a box was prepared provided with a frame fitting closely in the top; over this frame was stretched netting, which was then thoroughly saturated with wax or paraffine. The box was then filled with a growing solution, containing of nutritive constituents the following proportion:

The amount of solution employed (30.5 liters) contained—

Potassic nitrate	30.5 grains, or 1.00	per cent.
Sodic nitrate	30.5 grains, or 1.00	per cent.
Calcic sulphate	9.15 grains, or 0.03	per cent.
Magnesic sulphate	9.15 grains, or 0.03	per cent.
Sodium chloride	12.3 grains, or 0.04	per cent.
Ferric chloride *	0.2 grains, or 0.006	per cent.
Calcic phosphate*	5.00 grains, or 0.0163	per cent.

Upon the netting were sown barley seeds, and the whole was placed in a favorable condition for germination and growth. After the roots had attained considerable development and all the nutritive material of the seed had been exhausted, the frame bearing the netting was removed from the box and the suspended roots freed from any adhering nutritive solution by washing in pure water. Care was observed that they should suffer no injury or laceration. They were then cut off close to the netting and placed in a mortar, some glycerine poured over them, and the whole triturated until the roots were finely divided; a small quantity of water was then added and the fluid separated by filtration through a linen bag.

*Rough approximation.

The solution thus obtained was then mixed with a considerable quantity of absolute alcohol and the resulting precipitate collected on a filter. After washing it was triturated in a mortar with glycerine, the soluble portion separated by filtration and treated with absolute alcohol as before. The product of this precipitation, after being collected, was then treated with water containing a small quantity of glycerine, and the solution thus obtained employed in the experiments with egg-albumen hardened by boiling, which were made as follows: To a small quantity of the solution a few drops of dilute hydrochloric acid and the pieces of hardened egg-albumen were added, and the whole allowed to stand in the warm part of the sand bath for 12 to 24 hours.

Hüffner's test was then applied, and in every case negative results were obtained.

The experiments were repeated three times with like results, proving the absence of the peptone-forming ferment in the roots. Repeated tests of like character made upon roots of the coffee-plant gave similar results.

Experiments to determine whether or not the roots themselves, by direct action, may have any dissolving influence upon hardened albumen have been projected, but must be left for the subject of future study; and there seem to be possibilities for interesting developments in connection with it.

AMERICAN SUMAC.

The rapidly increasing consumption of sumac by tanners of light leathers and by dyers causes a demand for this article which has, during the past few years, awakened a lively interest in the matter of the collection of the spontaneous growth of the same in this country, and in many instances has stimulated inquiries into the manner of its cultivation abroad and the more improved methods employed in its collection and preparation for the markets. In Virginia particularly, where the spontaneous growth of sumac is very abundant, it is estimated by Mr. Cornelius S. Ramsburg, of Georgetown, D. C., who has given a great deal of attention to the subject, that the amount collected this year will exceed 5,000 tons. It is difficult to obtain any reliable figures for the entire country from the fact that none are recorded concerning this very important industry. In all probability, however, those given above are too low, since in 1872 the existence of large areas along the Missouri River, densely covered with a growth of sumac, were reported to this department, and in the same year 12,000 pounds of the ground product were shipped to New Brunswick, N. S., by way of New York, from that locality. What may have been the development of the industry there and elsewhere since that time we have been unable to determine. However, accepting Mr. Ramsburg's figures, this does not represent one-half the consumption, as may be seen from the following table showing the importations during the ten years from 1867 to 1876 inclusive:

Year ending—	Quantity in pounds.	Value.
June 30, 1867	13,790,990	$559,421
1868	11,842,451	468,362
1869		536,083
1870	9,634,367	418,919
1871	10,341,787	420,823
1872	10,028,912	383,570
1873	13,160,114	463,780
1874	16,718,678	511,941
1875	16,542,548	533,713
1876	17,642,960	624,169

We see, therefore, that the annual consumption of the foreign product approximates 8,000 tons. This does not take into account that brought in by smuggling and false entries, which is said to be very considerable. There is another important comparison to be made here, viz., the difference in the value of the foreign and that of the home product. The value of the importations for 1876 amounts to the sum of $624,169 gold, while the value of the American product will not exceed $420,000 currency. Later advices from a private source state that the importation of sumac for the present year amounts to 11,000 tons, or $1,100,000 gold, estimating the value of the product at $100 per ton. Yet it has been conclusively proven that the proportion of tannic acid in the latter exceeds that found in the former by 6 or 8 per cent. It has often been stated that this difference in favor of the American product is very much greater, but my own investigations have failed to confirm such statements, and I have been unable to find any reliable analyses that support them. Notwithstanding this higher percentage of tannic acid in the American product, we undertook this summer to determine at what time during the season it is at the maximum, in order, by giving instructions concerning the time for collection, based upon the results of such investigation, to bring about a possible improvement in the product. At the same time it was obvious to us that we must look to some other source for the main cause of the difference in the values of the American and Sicilian productions, and why the latter is so much preferred by tanners and dyers. Upon inquiry among the dealers and practical tanners, we find that by using sumac of Sicilian growth and manufacture it is possible to make the finer white leathers so much used for gloves and fancy shoes, while by the employment of the American product the leather resulting has a disagreeable yellow or dark color. Many attempts have been made by those interested in collecting and grinding, by careful attention to the methods employed, to improve the quality of the home product and save the extra $50 per ton which is the present difference between the prices of American and Sicilian sumac.

In many cases these attempts have been partially successful, but not entirely so, and, as will appear below, the difficulty in question cannot be altogether remedied in this way. Since the present analyses, and those published elsewhere, show a higher percentage of tannic acid in favor of the American product, it is evident that the difficulty must depend entirely upon a coloring matter, which, according to Loewe (Fresenius's *Zeitschrift für analytische Chemie*, 1873, pp. 127, 128), consists of quercitrine and quercitine, which exists in larger quantity in the American than in the Sicilian.* Endeavors were made to determine a ready and practical mode by which the separation of these coloring matters from the tannic acid in solution and their estimation might be effected, but from the fact that their deportment with reagents is so similar to that of tannic acid, and their solubility in water appears to be so much modified by the presence of tannic acid, our endeavors to this end were unsuccessful. But while there may be no practicable method which may

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*In the progress of my work I succeeded in separating a brown crystallized substance in the following manner: An extract of 100 grains of Fredericksburg sumac, containing 23.71 per cent. of tannic acid, was treated with solution of plumbic acetate, and the resulting precipitate, after separation by filtration and washing, was rubbed up with alcohol, and finally placed in suspension in a large volume of alcohol, through which sulphureted hydrogen gas was subsequently passed, until complete decomposition of the lead compound was effected. After separating the sulphide of lead and slightly concentrating the alcoholic solution, the crystals formed.

The crop obtained was not sufficient for complete examination, and the substance must, therefore, be the subject of future investigation.

be applied to the separation of the coloring matter when in solution, we believe we have discovered how it may be entirely avoided. The manner in which this may be affected will appear later on.

In the mean time let us compare the percentages of tannic acid in the product as indicated by our estimations in specimens collected at stated intervals during the season. Through the courtesy of Mr. German Smith, of Winchester, Va., samples of sumac were collected in the months of June, July, and August respectively. Of these samples those collected in June and July were mixed varieties, and of the product collected in August we secured samples of the leaves of *Rhus glabra* and *Rhus copallina* separately. For comparison with the Virginia material, and for use in the latter portion of the work, we applied to Mr. William S. Soule, of Boston, Mass., for a sample of Sicilian sumac, and he very kindly and very promptly supplied it. In all of these samples the tannic acid was estimated by means of the method of Jean, published in the *Bulletin de la Société Chimique de Paris*, and mentioned in the annual report of the department for 1876. I may state here that I found it convenient to modify somewhat the method as laid down by Jean. For instance, a decided improvement was experienced by increasing the strength of the iodine solution from 4 grains iodine per liter to 8 grains per liter, and with the solution of this strength I obtained exceedingly satisfactory results.

For the analysis I took 5 grains of each sample, placed them respectively in a casserole, poured upon them about 150 cubic centimeters of distilled water, and heated to boiling about fifteen minutes. After partial cooling and settling, the solutions were poured through linen filters, and the residues treated in a similar manner with water until all tannic acid was extracted. After the last boiling the whole was placed upon me filter, and when the liquid had nearly all passed through, the portion remaining was forced through by pressure. The solutions were then made up to 500 cubic centimeters, and for each assay 10 cubic centimeters were taken. The results obtained are indicated in the following table:

Variety.	Time of collection.	Percentage of tannic acid.
Winchester mixed	June	22.75
Winchester mixed	July	27.38
Winchester *Rhus glabra*	August	23.56
Winchester *Rhus copallina*	August	16.99
Sicilian *Rhus coriaria*		24.27

It is evident, therefore, that in order to secure the maximum amount of tannic acid the sumac should be collected in July.

But, as before stated, the coloring matter of the leaves has an important influence upon the value of the product, and it appeared of value to determine when it was present in smaller quantity.

At first it seemed reasonable to suppose that leaves from the young growth of wood, in which the coloring matter is not yet formed as in the older wood, might be collected and found free from this troublesome substance, but examinations proved that this is not the case. I therefore determined to make some experiments upon the color of precipitates with gelatine, made by means of solutions of the material collected in the different months, having the same strength in tannic acid for each. For the purpose of experiment, the qualities indicated in the following table were taken, and to each specimen was added about 150 cubic centimeters of distilled water, and boiled for fifteen minutes, filtered through linen, and pressed out without washing, replacing the water which had been removed by evaporation during the boiling, and otherwise making the volume of each solution up to 150 cubic centimeters.

Variety.	Collected in—	Amount, taken in grains.
Winchester mixed	June	4.4
Winchester mixed	July	3.65
Winchester *Rhus copallina*	August	5.8
Winchester *Rhus glabra*	August	4.25
Sicilian		4.1

The gelatine solution employed contained 5 grains in 150 cubic centimeters of water. In the experiments I took 50 cubic centimeters of each sumac solution, and added thereto 10 cubic centimeters of the solution of gelatine. The colors of the precipitates obtained were as follows:

Variety.	Collected.	Color of precipitates.
Winchester mixed	June	Nearly white.
Winchester mixed	July	Decidedly yellowish-white.
Winchester *Rhus copallina*	August	Dirty yellow.
Winchester *Rhus glabra*	August	Very dirty white.
Fredericksburg mixed		Dirty yellow.
Sicilian		White, slightly yellowish tinge.

In some of the tests, the precipitates obtained by means of the solution of the June collections of Winchester mixed sumacs were perfectly white and very much cleaner than any obtained with the Sicilian product. The difference in the color of the precipitates obtained from the solution of the June collection and that obtained from solutions of the samples of later collections, was sufficiently marked to prove that the great difficulty in the way of the universal employment of the American to the exclusion of the expensive Sicilian product *may be obviated by making our collections early in the season; that is, in the month of June.* The percentage of tannic acid is not, it is true, quite as high as obtains in July, but it compares favorably with the Sicilian product, which, be it remembered, communicates a slightly yellowish tinge to the gelatine precipitate. The amount of coloring-matter found in the July collection is sufficient to account for the difference of $50 per ton in the market values of the sumac of home and foreign growth, regardless of the proportion of tannic acid. We would therefore advise that, for the purpose of tanning white and delicately-colored leathers, the collection be made in June, while for tanning dark-colored leathers, and for dyeing and calico-printing in dark colors, where the slightly-yellow color will have no injurious effect, the collections be made in July. It appears that for all purposes the sumac collected after the 1st of August is inferior in quality. In view of the facts here presented, we cannot help urging upon manufacturers the importance of encouraging the home producttion—of insisting that the collections be made early in the season, in order thus to bring about such a change in this matter as to prevent the annual expenditure of over $600,000 in gold for the sumac of foreign growth. They may insist upon a classification, depending upon the time of collection and the behavior of aqueous solutions of the material with solutions of gelatine. They might also insist upon a guaranteed percentage of tannic acid. By encouragement of the home trade and home productions, there is no reason why the enormous annual expenditure above referred to should not be saved to American producers.

If the classifications mentioned were required, those interested in the collection would take care to secure the best quality in the product, by the means here shown to be at their command, while merely an offer of an advanced price, which the consumers can readily afford, would doubtless be sufficient to bring this about, and at the same time induce others to engage in the enterprise of collection, so that in a short time the home supply would be not only ample to meet the home demand, but also to make a good surplus for export to foreign markets. And all this may be secured from a spontaneous growth upon lands that would otherwise be almost utterly worthless, and with no immediate demand for the cultivation of the shrub. The importance of the matter also warrants the encouragement on the part of our legislators in Congress by the increase of the rate of duty now imposed upon the importations of sumac. Such increase should not be made of immediate effect, but should be deferred until after the 1st of August of the coming year. No inconvenience would be then felt by consumers on account of deficient supply to meet the present demands and the advanced cost consequent thereupon, while the increased supply of the home product that must follow such encouragement would be sufficient to meet future demands. In connection with this subject, a synopsis of the method of grinding and separating the different grades of sumac, which is described in the annual report of the department for 1869, may be of some interest.

Through Mr. Cornelius S. Ramsburg we have secured specimens of the products from the different stages of the process employed, and have taken occasion to estimate their value with reference to the tannic acid they contain. The raw material, as brought to the mill (for complete description of mill, see annual report for 1869), is passed through the grinding apparatus, and from this, after grinding, is passed through a revolving screen, divided into two sections, the first of which is provided with a sieve with 36 meshes per square inch, while the second part has but 9 meshes per inch.

The products resulting are:

1. Ground sumac, grade No. 1.
2. Fine stems and unground particles of leaves.
3. Coarse stems.

The second product is again passed through the mill, and the useful product resulting is ground sumac, grade No. 2.

No use is made of the coarse stems, but it has been suggested that on account of the considerable proportion of yellow coloring-matter they contain, they be employed in the production of flavine. Whether they may be thus applied must be the subject of future experiments. Estimations of the tannic acid in these several products gave the following results:

	Per cent.
No. 1 sumac	26 to 28
Exhausted stems	6.14
No. 2 sumac	14.72

The quality of the No. 2 sumac is often improved, before sending it to the market, by admixture of that of grade No. 1 sufficient to increase the proportion of tannic acid in it to 18 or 20 per cent.

Mr. Ramsburg's kindness has also enabled me to make estimations of tannic acid in varieties of sumac which grow extensively in Virginia, other than those analyzed and mentioned in the previous tables, and he has brought in specimens of *Rhus glabra* and *Rhus typhina*. In the following table we compare the percentage of tannic acid they contain with that found in the *R. glabra* and *R. copallina* of Winchester. They were all collected in August, and do not give a maximum yield, but the figures below will serve to a certain extent to compare them:

R. typhina, Georgetown, D. C	16.18
R. glabra, Georgetown, D. C	16.50
R. glabra, Winchester, Va	23.56
R. copallina, Winchester, Va	16.99

These estimations should be duplicated during the coming year, upon specimens collected at favorable seasons. It is probable that a comparison between the varieties might lead to some facts of great value to collectors and dealers.

ON THE CONDITIONS IN NATURE WHICH MAY INFLUENCE OR TEND TO THE PRODUCTION OF MILDEW AND ROT.

The subject of mildew and rot has been carefully studied by eminent men. Nearly all sides of it have been considered by one and another, many useful methods for its prevention and removal having been suggested. By some writers it is said to be produced by long-continued, warm, damp weather, or by sudden changes of temperature. Others attribute the cause to damp or dry weather, according to the variety of fungus which appears. It is a prevalent belief among very many students of fungalogy and vegetable physiology that a plant can be attacked by mildew only when in a debilitated condition; and starting out with this general proposition, it is my intention to cite some of the conditions in nature with which all are familiar, and which may have a tendency to affect the plant in such a manner as to render it susceptible to the attacks under consideration. To elaborate the proposition, we accept the theory that mildew, *i. e.*, fungous growths, can injuriously affect plants of the higher order on which they exist only when they are in a debilitated condition and there is an interruption of the process of elaboration of the plastic material, during which the plant, by its vital functions, is unable to resist the advance of the germinating fungous spores. The debilitated condition need not be sufficient of itself to affect the plant injuriously, and it may be capable of recovery from such condition, but during the continuance of the latter the mycelium of fungi may effect penetration to the cell tissues, and having done so, may, as many vegetable physiologists believe, of itself be able to keep up a debilitated condition in the immediately surrounding parts, which in a short time may extend throughout the entire plant, admitting the free advance of the fungous growth and ultimately producing the death of the plant. As above stated, sudden changes of temperature are named among the prime causes of this troublesome malady, and this brings us, first, to the consideration of the influence of temperature on vegetation. In his admirable work on botany, Sachs says:

> On this subject, the important fact must first be noted that the exercise of every function is restricted to certain definite limits of temperature within which alone it can take place; *i. e.*, all functions are brought into play only when the temperature of the plant or of the particular part of the plant rises to a certain height above the freezing point of the sap, and cease when a certain maximum of temperature is attained, which can apparently never be permanently higher than 50° C. (122° F.). Hence the life of the plant, *i. e.*, the course of its vital processes, appears to be confined in general within the limits zero (32° F.) and 50° C. (122° F.). It must, however, be noted that the same functions may have very different limits between 0° (32° F.) and 50° C. (122° F.) in different plants, as is also the case with different functions in the same plant.

Further on he says:

That growth, like other phenomena, is more active the higher the (constant) temperature above the inferior limit, but there is a certain temperature at which growth reaches its maximum activity, and above which any further rise of temperature causes a diminution of its rapidity.

We see, therefore, that the vital functions of the plant may be interrupted, or at least rendered less active, by extremes of temperature, which in case of some plants are not very wide; and for those most affected by mildew and rot during growth, probably, upon thorough examination, will be found to be between 10° C. (50° F.) and 45° C. (113 F.).

Again he says:

The injury resulting from too high or too low a temperature may, under certain circumstances, be indirect and slow in its manifestation. This will be the case when a particular function is too highly excited or too much depressed, and thus the harmonious co-operation of the various vital processes is disturbed. Thus, growth may be so excited by too high a temperature that assimilation, especially when the light is deficient, is not sufficient to supply the necessary formative material, and the transpiration of the leaves may, in addition, be so much increased that the activity of the roots is insufficient to replace the loss.

On the other hand, too low a ground temperature may so depress the activity of the roots that even small losses by transpiration from the leaves can no longer be replaced.

The matter of mineral nutrition is also an important factor to be considered in connection with this subject; for with a deficiency of mineral elements, such, for instance, as potassium and phosphoric acid, there must be diminished activity in the transformation of the plastic material in the plant into vegetable tissue.

The conditions which may produce the debilitation above referred to, and for which we desire to point out familiar causes, may be reduced to—

I. Variations of temperature.

II. Temporary or continued deficiency of mineral nutrition.

The first may consist of—

1. Cold or reduction of temperature.
   A. By radiation.
   B. By evaporation.
   a. From the surface of the leaves.
   b. From the soil.
2. Heat or increase of temperature.
   A. By direct radiation.

We have, then, first to consider cold produced by radiation. On this subject, Sachs says:

The radiation of heat is a very frequent and rapid cause of change of temperature in most parts of plants, the chief effect of these changes being to bring about differences between the temperature of the surrounding medium and that of the plant, especially when the parts of the plant are small of size but have large hairy surfaces, as is the case with many leaves and internodes. It must be noted in this connection that the radiating power is equal to its absorptive power, and that radiation depends not merely on the temperature, but also on the diathermacy of the surrounding medium.

This corresponds with the observations on the causes of the formation of dew, made first by Wells and after him by Melloni, Glaisher, Martins, and others. They found that on clear nights the temperature of the plant was reduced to a much greater extent than on cloudy or partially-cloudy nights; and the celebrated author above quoted says: "How greatly the temperature of parts of plants of considerable superficial extent may be depressed by radiation below that of the air, is shown by the fact that a thermometer placed on the grass exposed to radiation indicates on clear nights a temperature several degrees lower than one placed in the air." Just here a consideration of the possible and probable variations of temperature necessary to the formation of dew, which is the visible result of this radiation, will be of interest.

If we examine the tables showing the difference of the temperature of the air and the dew-point, we find that it varies widely with the relative proportion of moisture in the atmosphere.

Thus, when the relative humidity is 70 and the temperature of the air is 70°, the difference between the latter and the temperature necessary to the formation of dew has been found to be 10°. When the relative humidity is 50 and the temperature of the air 73°, the variation becomes 20°; while if at the same air temperature the relative humidity be 43, the variation will be 25°. With the relative proportions of moisture here given, and with higher temperatures, these variations become still wider. We see, therefore, that during the dry weather that often occurs during the summer months, vegetation suffers not only from deficient moisture to supply its demand, but also from very much wider variations of temperature due to radiation. Indeed, it is during the prolonged summer droughts that we generally notice the heaviest dews.

Now, let us see what will be the temperature to which the plant must be subjected in consequence of this reduction due to radiation. Wells found that a thermometer laid upon a grass-plot on a clear night sank sometimes 14° lower than a similar theremometer suspended in free air at a height of four feet above the grass; and the observations of Pouillet seem to show that the diminution of temperature attending the production of dew is at all times sensibly constant at about the figure determined by Wells.

Our summer-night temperature usually varies between 70° and 85° F. With the reduction which must take place when the relative humidity is 70, we will have temperatures ranging from 60° to 75°; with the relative humidity of 50 we will have temperatures of 50° to 65°, while with the relative humidity of 43, which could, of course, occur only during very dry weather, the temperature would fall to 45° to 60° F.

But these are considerably below the lower limits of temperature at which it has been found by careful observation the movements of protoplasm and the transformation of plastic material can take place, and which, for even such hardy plants as the *Phaseolus* (bean) and *Zea mais* (corn), is stated at about 61° F. The lower limit for the more tender plants is doubtless much higher than this, so that it is easy to see how they may suffer and become debilitated by the *cold* of summer nights.

But the germination of fungus spores and the growth of mycelium, may take place at a much lower temperature and during the temporary interruption of the transformation of plastic material, which must occur at the reduced temperatures mentioned. The mycelium of the germinating spore may effect penetration through the epidermis of the plant into the cellular tissue beneath, where it may feed upon the dormant protoplasm, which is already fitted for assimilation.

This result having been arrived at, the recovery of the plant from the abnormal condition produced by the reduced temperature, which would otherwise take place, will be prevented, leaving the plant in condition favorable to the rapid growth and spread of the fungus even to the death of the plant.

But while the discoveries of Wells and his colleagues showed under what conditions radiation of heat from the plant into space and the production of dew could take place, they also showed how it could be prevented, and in this they give us a remedy for one of the possible causes of mildew and rot. They found, what is familiar to all, that dew is not formed on cloudy nights nor in sheltered positions. Indeed, one of Wells's experiments to show that the radiation of heat took place, and that the formation of dew went hand in hand with it, was to arrange a board or piece of pasteboard on props and note the temperature and the production of dew in the grass below it and on some cotton wool on the top of it. He found that beneath the cover no dew was produced, and there was at the same time no reduction of temperature.

An experiment showing the practicability of the application of this idea to the prevention of mildew in many cases was made several years ago near Baltimore by Mr. William Saunders, present superintendent of gardens and grounds of the Department of Agriculture. He placed over a row of grape-vines simply a cover of boards, and as a result he found that no mildew appeared upon these vines, while those of an adjacent row which remained uncovered were severely attacked by mildew, and were almost entirely destroyed.

An objection might be raised against this method of prevention on account of the undesirable shade it would probably produce during the day, but this difficulty might be obviated by the use of glass if it were considered necessary. This would admit the passage of light but not of radiant heat from any other than an incandescent source, such as the sun. In many vineyards, however, where the only support to the vines is a simple pole or post, this could be surrounded by a square or circular screen made of thin boards. As the method has been successfully tried, it might be applied in many other cases that I shall not here take occasion to mention.

We now come to the second cause of reduction of temperature, *i. e.*, *evaporation;* and under this head we shall first consider that which may take place from the surface of the leaf. We have seen how debilitation of the plant, due to an interruption of the vital processes by cold, may be produced, and I propose here merely to show how evaporation may bring about the necessary conditions, and that it is often and indeed almost invariably followed by the appearance of fungus growth. Quoting again from Sachs, we find that "in the aerial parts of plants transpiration is an energetic additional cause of loss of temperature, inasmuch as water in the act of evaporation withdraws from the plant the amount of heat necessary to its vaporization, and hence makes it colder." If water upon a leaf be allowed to evaporate slowly, no injury results; but, if a current of dry air of average temperature, or even warm air, be caused to pass over it, a reduction of temperature will take place often greater than will occur in the production of dew. Indeed, it is well known in the graperies connected with the department that the vines may be wet with the syringe two or three times a day with no injurious effect, but rather a beneficial one. The atmosphere may thus be kept exceedingly moist for weeks, and even months, and no mildew will appear; but if at any time one of the windows or ventilators be opened so that a current of dry air may pass over a portion of a vine, its course will invariably be marked by a copious formation of mildew. This shows, therefore, that plants which are the most subject to attacks of mildew should be protected as far as possible from currents of dry air.

In the Azores this fact is illustrated in the improvement in the yield of the orange-groves after the high walls were built around them to protect them from the heavy gales which formerly proved so destructive. While providing shelter for their trees from the heavy gales, the orange-growers were also protecting them from the lighter currents of air which, by increasing the evaporation of water from the leaves, tend to the production of cold, and consequently of mildew.

The remedy here suggested has more ready application than that mentioned under radiation, and might be used to advantage not only by grape-growers but also by fruit-growers in general. Indeed, I am told its practice is not new in England, for there the horticulturists build covered glass houses in which they plant fruit trees and vines. They therefore serve as a protection to the more tender fruits, and also to the grapes in the grounds, and have been found to be exceedingly beneficial in their effects.

It is not necessary that our horticulturists should practice the expensive English method of using glass, nor that followed in the Azores of building high stone walls, but high fences of wood could be constructed that would serve the same purposes, and would, I think, be within the reach of most fruit-growers. This fence may be replaced, or rather rendered permanent, by means of hedges of the more dense evergreens.

The next important cause of cold in relation to plant-growth is evaporation of water from the soil, and of this merely a brief consideration is necessary, since the facts relating to it are so evident.

Water is often allowed to collect in the soil with no means of exit other than by evaporation, and this means the absorption of a definite quantity of heat. Thus, it has been determined by observations and experiments made in the domain of thermodynamics, that for the evaporation of 100 pounds of water the amount of heat required or absorbed is equal to that produced by the combustion of 6.35 pounds of anthracite coal or 6.29 pounds of bituminous coal. Now, taking three inches as the average monthly rain-fall during the summer months, the amount of water to be evaporated from one acre of soil with deficient under-drainage, not taking into account surface-drainage, will require as much heat as would be produced in the combustion of 50 tons of anthracite coal. If we take two inches as the average monthly rain-fall during the summer months, the loss of heat due to evaporation would be equal to that resulting from the combustion of about 35 tons of coal. These figures, as above remarked, do not recognize any drainage whatever, and the loss of heat due to the cause in question will, of course, diminish in proportion to the facilities for drainage. With these facts in view, it is obvious that in the search for causes of mildew this matter of water in the soil should be taken into acconnt, and it would seem useless to urge the importance of under-drainage. Many writers urge the injury resulting from excessive moisture, and refer fungus growth back to this as the main cause, but it does not seem to occur to them that plants may grow and mature in water containing all the elements of plant-food, and if the temperature of the water be maintained, fungus growth will not appear. The cause in such cases is therefore not the presence of the water, but the loss of heat due to the evaporation of water,* and this evaporation can, of course, be prevented by thorough drainage.

In the classification of causes of debilitation we find next, heat, or increase of temperature, and to some of our readers this may seem out of place, since all vegetation is so luxuriant during the heated summer term; but, as above shown, we find that the higher limit of temperature at which the vital functions of the plant may act is fixed at about 120° F., and this temperature is often exceeded in situations exposed to the direct rays of the sun.

If, in such situations, the amount of moisture supplied to the plant be not sufficient to satisfy the demands made by transpiration, thus keeping up the equilibrium of temperature by evaporation from the leaves, the temperature of the exposed parts of plants will exceed the limit favorable to the movements of the protoplasm, and they must necessarily suffer and pass into the conditions favorable to the attacks of mildew. The remedy

* I, of course, also recognize the fact that the excess of water existing in the soil on account of deficient under-drainage may act injuriously by preventing the circulation of atmospheric oxygen in the soil, for the oxidation of the organic matter necessary to plant-nutrition. It makes this a double cause of the debilitation in question.

in this case, as in the others cited, suggests itself, and will doubtless be found in judicious irrigation whenever it may be necessary. The methods to this end will, of course, vary with the plant under treatment.

Another but less frequent cause may possibly be found in the condensation of the heat rays of the summer sun by drops of water resting on the surface of the leaf. The drops under such circumstances being usually globular, the focus of the concentrated rays will be found at the surface of the leaf, and the temperature of the particular spot will consequently be increased beyond the higher limit for growth. The favorable condition exists for a short time, it is true, but probably long enough for the rapidly growing mycelium to effect an entrance to the cellular tissue, and secure a firm and fatal footing there.

This cause is more hypothetical than the others cited, but, like the others, might be the subject of some interesting experiments to corroborate it. Such experiments I have planned, but have as yet been unable to execute them for want of time. The only requirements are plants which are frequently subject to attacks of fungus growths, a good reflector, a strong incandescent source of radiant heat, and a good and rapid absorbent of radiant heat. These may be arranged in a convenient manner, so that the *plant* under experiment may be subjected for a given time to the influence in question, then allowed to assume normal conditions and the effect will be noted. For instance, the plant may be placed in front of the reflector, in the focus of which may be held a quantity of freezing mixture. The plant should be allowed to remain there until by radiation of its heat its temperature has been reduced to or below the dew-point, and after the production of dew upon it again allowed to remain under normal conditions. After a reasonable time the difference between the plant experimented upon, and one remaining, with that exception, under precisely similar conditions, should be noted. The production of mildew as a secondary result, or its non-appearance, would prove the truth or falsity of the theory hereinbefore advanced.

The truth of the theory of the next cause of debilitation of plants sufficient to admit of the successful growth of fungi upon them, has received partial confirmation, at least, under my own supervision in the experiments about to be described, relating to the influence of deficient nutrition upon mildew and rot. For this purpose I had large boxes prepared, six feet square and three feet deep, in the center of which was placed a smaller one three feet square, of the same depth, and having a bottom in common with the larger one. The entire bottom was provided with numerous holes to admit of the free passage of water. The whole arrangement was placed in a tray about three inches deep, and supported about one inch above the bottom thereof. The outer and larger box was filled with soil to prevent any outside influences of temperature, &c., while the inner box was filled with ordinary soil of the field; two of the inner boxes of this description were entirely filled with garden soil, and a third was half filled with garden soil; the remainder being pure river sand. The three boxes were conveniently placed that they might be covered with glass at a distance of five or six feet above them.

The original idea with regard to the special matter under investigation in these experiments was, that during the dry weather in summer plants must be supplied with the moisture necessary to their growth by water carried up from the subsoil by capillary attraction; that this water is charged with mineral matters, nearly all of which are suitable for plant-food. It also carries with it the decomposition products of the soil, and thus the roots are continually supplied with the mineral ingredients of food necessary to their healthy growth. But in case of heavy rains, if the conditions of drainage be good, and they must, of course, be so to satisfy the demands of the conditions above, the flow of water in the soil must be reversed. The rain-water from the surface will, in its passage to the subsoil, take up and carry with it the soluble elements of plant-food. The plant, by the increased moisture, will be stimulated to increased growth, but from lack of the mineral matters which have been carried away by the reversed flow, a sluggishness in the transformation of the plastic material in the leaves must occur, and until the supply of mineral matter returns to assist in the processes of assimilation, &c., there must exist a condition favorable to the successful advances of the fungus growth described above, and the plant must necessarily suffer.

In the experiments under consideration the aim was to produce artificially the conditions here described. The boxes were covered, and there was no danger from loss of heat by radiation. They were placed in sheltered positions, and were not much subject to air currents. Solutions were prepared containing all the elements of plant-food, and the trays in which the boxes were standing filled therewith.* Seeds of wheat, oats, and pease were sown in the soil of the inner boxes, and no water supplied except to the trays. The moisture necessary to the growth was, therefore, obtained only from the bottom by means of capillary attraction. The plants grew well, and about the time the blossoms were falling from the pease, and the fruit was forming, the solution was drawn off from the trays and the plants watered heavily with rain-water for several days—*i. e.*, artificial rains were established equivalent to a rain-fall of three inches or more each day. This was continued for some time, and on account of the character of the soil employed the removal of the nutritive principles from the soil about the roots was rendered very difficult. The plants subjected to this treatment, which previous to it were entirely free from any appearance of mildew, became subsequent thereto covered with fungus growth. This was especially true of the pease.† Rust was also found abundantly on the wheat and oats.

* The nutritive solution employed had the following composition:

	Per cent.
Bone-meal (in form of bone-meal superphosphate)	.179
Actual percentage of the superphosphate	.239
Potassium nitrate	.045
Calcium sulphate	.155
Potassium sulphate	.041
Magnesium sulphate	.054
Iron chloride	trace.
Total numeral constituents, something more than	.668
Water, less than	99.332
	100.000

† *Application of artificial rain and appearance of mildew.*

[Each box received the same amount of rain at each application.]

Rain.			Mildew appeared in—
When applied.		Amount applied.	
		Inches.	
September	20	3	
	21	3	
	22	3	
	23	3	
	26	....	Box No. 1.
	28	4	
	29	5	
October	1	6	
	2	6	
	12	....	Box No. 2.
	13	4	Box No. 3.

The treatment with rain-water had to be long continued on account of the richness of the soil, as above stated. Since the soil employed was rich the water applied through the trays should have been simply river water, which would correspond more nearly in composition with the underground waters upon which plants must depend for their moisture during extended dry seasons; this would obviate the excess of nutritive material that must be washed out to secure marked results.

These experiments, therefore, while they afford partial confirmation of the theory advanced, should be repeated under modified methods; thus, instead of using fertile soil, clean river sand with convenient admixture of pure clay, sufficient to provide the proper capillary power, should be employed as the basis of soil, as nutritive solutions, such as that employed in the present experiments, could then be applied through the medium of the trays and the perforated bottom of the box. After a given time the supply of material to the bottom would be stopped as before by drawing off the nutritive solution, and the artificial rain established.

There should be three sets of boxes. For one set the conditions established at the start should be maintained throughout the entire investigation. To the other two sets the artificial rain should be applied, and to one of these two, at the end of the rain, nutritive material in solution should be applied to the surface of the soil. It is easy to see that if a number of boxes were prepared and treated after the manner here indicated, and the results noted, sufficient facts ought to be obtained in a single season to determine the question of the influence of heavy rains in summer on the mineral nutrition of vegetation, and remotely upon the question of mildew and rot. If upon the plants in the boxes, allowed to remain under the same conditions, no mildew appears, while upon that heavily watered it does appear, as in the experiments made during the past summer, it surely establishes a cause; and if while it appears upon one of the boxes thoroughly watered, but without subsequent application of nutritive material, it is not found on the other box submitted to exactly the same treatment, but receiving after the artificial rain nutritive material in quantity sufficient to satisfy the temporary demands of the crop until the return of the former supply, we surely determine a remedy. These are ideas that may be experimented upon in a practical way by horticulturists, and especially those who are working upon sandy soils, where leaching can more readily take place. Just after a continued summer rain let some of the vines or trees be supplied with fertilizing material, while others are left subject to the usual conditions, and note the appearance of fungus growths. Such experiments may perhaps be of no avail, but the time and means thus expended, if lost, will be lost in a good cause.

That exhaustion of the soil has a strong influence upon this matter finds, I think, ample corroboration in the present condition of the vineyards of many of the islands of Lake Erie, where, I have been informed, grapes have been grown on the same soil for twenty-five years, successively, with the application of no fertilizer whatever. During the earlier part of this term mildew and rot was scarcely known, but during late years the crops have been almost total failures. I am unable to say how far this difficulty may be due to removal of the protection from winds, &c., by clearing off the forests, but the failure to apply fertilizers has certainly been of material assistance in the fatal work, and the grape-growers there will, if they desire to grow good crops, have to bear in mind and practically apply the facts, that the waste and exhaustion of the stock of phosphoric acid and potash soil must be supplied for the healthy existence of the plant family as surely as the stock of bread and beef must be renewed for the support of the human family.

During the year a great many investigations have been suggested and a great deal of work required that it was impossible to perform. It has been the constant endeavor of the division to confine the work to such matters as have not merely a local but a national importance, and to such as might prove of general scientific interest. At the same time, the practical application of the results obtained has been kept in view, and whenever any methods to that end have been suggested by the results of the work, they have been commended to the attention of those interested in the matters under consideration. Particular attention has been given to work that might tend to the establishment of new industries and provide employment for laboring classes in need of new sources of labor and income.

In closing this report, I desire to express the earnest hope that the division may receive such encouragement and such advancement in the future as will extend the scope of its work and importance, and increase its power and influence for good to the agricultural classes, and the promotion of chemical science as applied to agricultural industries.

Respectfully submitted.

WM. McMURTRIE,
Chemist in Chief.

To Hon. WM. G. LE DUC,
Commissioner of Agriculture.

REPORT OF THE ENTOMOLOGIST AND CURATOR OF THE MUSEUM.

SIR: I respectfully submit the following reports: first, upon the *Hymenoptera* (bees, wasps, &c.), with descriptions and figures of those species especially injurious to agriculture, or interesting from form, habits, &c., and the second upon the condition of the museum, with a systematic classification of objects and brief outline of recent noteworthy additions.

HYMENOPTERA.

This order comprises insects having four wings generally transparent, naked, and furnished with a few branching veins, which are not reticulated or netted like those of the *Neuroptera* or dragon-flies. The name *Hymenoptera* is derived from two Greek words signifying a membrane and wing, from the structure of their wings, the two forward or anterior pair of which are generally larger than the posterior pair.

This order includes saw-flies, ichneumon flies, ants, wasps, bees, &c., and appears to form a sort of connecting link between the *Mandibulata*, or insects possessing jaws, like the *Coleoptera* or beetles, &c., and the *Haustellata*, or insects furnished only with sucker or proboscis, like the two-winged flies and true plant-bugs. The upper jaws of the *Hymenoptera* are stout, horny, and formed for biting or rending, while the two lower jaws form a sort of tongue or sucker for sucking or lapping vegetable or animal substances. Many of the females of the *Hymenoptera* are furnished with a poisonous sting or prickle at the hinder end of their body, for offense or defense against their numerous enemies, while others are provided with a piercer or ovipositor of some kind to bore into vegetable substances, to cut holes in leaves, &c., in which to deposit their eggs, like the saw-flies, or to pierce the bodies of other insects, where their maggot-like larvæ, when hatched from the eggs, live upon the juice of caterpillars and other insects, the bodies of which they inhabit and eventually destroy, thus proving exceedingly useful to the farmer.

Several of the insects of this order display great sagacity or instinct in the storing up of their food and the care of their young, as exemplified by the bee, &c., not leaving them like the eggs of most of the other insects to mere chance to be hatched or fed. Insects of this order may be divided into two general divisions, *Terebrantia* or borers, and *Aculeata* or stingers. Westwood in his classification commences with the *Terebrantia* and finishes with the *Aculeata*, whereas other later authors commence with the *Aculeata*. We shall, however, partly follow Westwood, as, although he is the older authority, he generally has been very correct in his classification and descriptions, and it matters very little in such a necessarily short treatise as this what classification may be adopted here, provided the principal beneficial and injurious *Hymenoptera* can be readily referred to in case of need. The first family of the *Aculeata* comprises the *Tenthredinidæ* or saw-flies, the larvæ of which live in wood, the leaves of trees, &c. *Cimbex ulmi* or *americana* (Fig. 1) is one of the largest of these insects, being nearly three-quarters of an inch in length and of a stout, thick form. The eggs are deposited on the elm, generally in June or July, where the larvæ feed upon the foliage, and when they are fully grown crawl down the trunk and form large, tough, parchment-like cocoons, in which they remain until spring or early summer, and after changing into the pupa state, they finally, in June or July, change into large thick-bodied flies of a violet or blue color, having generally three or four oval yellowish or orange spots on each side of their body. The antennæ and lower part of legs are clay colored, somewhat resembling the spots. The larva is of a whitish color and rolls itself in a spiral form when on a leaf, and not only feeds upon the elm, but also upon the foliage of birch, linden, and willow. *Abia cerasi* or the cherry slug, in the larva state, is said to feed on the leaves of the wild cherry. They are about 0.60 in length and the fly is black, with pale-yellow feet, and appears about March in the State of New York. The larvæ of *Abia caprifolia*, or saw-fly of the tartarean honeysuckle, hatch out very early in the season, and when at rest lie curled upon a leaf and eat the foliage; when disturbed they emit a drop of watery fluid from the sides of their bodies and are easily destroyed, as when touched they drop suddenly to the ground where they are readily crushed under foot; they change into pupæ in pale-yellowish silken cocoons later in the summer or fall. The insect is 0.36 in length and 0.70 in expanse of wings, and is of a black color with a faint greenish reflection and two whitish bands at the base of the metathora; the wings are banded. The rose-slug or saw-fly, *Selandria rosæ* (Fig. 2), is a very common little saw-fly, injurious to the foliage of the rose. The eggs are deposited in May or June, in incisions made by the ovipositor or saw of the female in the leaves, each incision containing one single egg; the larvæ hatch out in about ten days and feed upon the parenchyma or fleshy part of the leaf; they cast their skins several times, and the pupæ are formed in small oval cells in the earth an inch or more under the surface. The larvæ are not slimy, and are of a pale-green color, yellowish on the under side. The male fly is 0.15 in length, the female 0.20. They are of a deep shiny black color, and the thorax is not red like some of the kindred species; the hind legs are black with whitish knees and the wings are smoky-transparent. There are two or more generations annually in Maryland.

Tobacco-water and soap-suds have been recommended to destroy the larvæ or "worms." Weak carbolic acid, whale-oil, soap-suds, or an infusion of quassia have also been reported as beneficial, but probably Paris green and flour, or white hellebore, applied either dry when the leaves are moist, or in a wet state, mixed with water, would effectually destroy the worms when feeding and not prove injurious.

Another somewhat similar insect is sometimes very injurious to the foliage of the grape-vine in early summer and autumn.

These insects are well known to grape-culturists as the grape-vine slug or saw-fly, *Selandria vitis* (Fig. 3). They feed in companies of several together, side by side, on or near the edges of the leaves; the larvæ are twenty-footed, of a greenish color above and yellowish beneath, and have several rows of black dots across each wing. The head and tail are black. The pupæ are formed in small oval cells in the ground. The perfect fly is shiny, black, with red shoulders; the fore legs and undersides of some are pale yellow; the female is about 0.25 in length, and the wings are semitransparent. Paris green ought never to be used to destroy these larvæ, as it is a very violent poison and might be dusted over the fruit. The root of white hellebore powdered, although somewhat poisonous if used in any great quantity, has yet proved very efficacious, and at the same time innocuous, when used for the currant worm, an insect of very similar habits; it is applied either as mixed with water or when in a dry state, dusted over the plants when moist with dew or rain. The fruit, however, should be well washed before using.

The other compounds of whale-oil, soap, tobacco-water, &c., are liable also to the objection of producing a disagreeable flavor to the fruit if applied incautiously. As these larvæ are in the habit of climbing together in rows upon single leaves, it would be very easy to pick off such infested leaves when the worms are very young and trample them under foot.

Air-slacked lime has also been used, but is not as efficacious as the powdered hellebore.

The larvæ of *Selandria rubi*, or the raspberry saw-fly, is a small twenty-two-footed, smooth green worm, which attacks leaves of the raspberry. It is said to be covered with prickles after the last molt. The same remedies as recommended for the other saw-flies may be applied to this insect if it should become numerous. *Allantus* is closely allied to *Selandria* in structure and habits. *Allantus basillaris* (Fig. 4) has been figured here to give some idea of the form of some of these insects. *A. mellosus* and *ruficollis* are very much smaller in size. The larvæ of *Allantus sambuci*, or the elder saw-fly (Fig. 5) feed upon elder and willow, and are also figured as found in Maryland. *Dolerus arvensis* is a somewhat similar saw-fly, of a blue-black color; the larvæ are found on the willow in April and May. Not possessing a specimen of this insect from which to make a drawing we are obliged to figure *Dolerus sericeus* (Fig. 6), which is a closely allied insect. *Emphytus maculatus* has nine-jointed antennæ. It does considerable injury to the cultivated strawberry-plants in the Western States. The female is said to deposit her eggs early in May in the stems of the plants; the larvæ, which are of a dirty-yellow or gray-green color, when at rest curl their bodies spirally, and when fully grown are about three-quarters of an inch in length.

They eat holes in the leaves and molt their skins four times, and the perfect flies appear the end of June or beginning of July. A second brood appears later in the season and remains in the earth until April. The fly is pitchy black, with two rows of dirty white spots on the abdomen. As we have not found this insect in our collection, we have taken the liberty of figuring an allied but larger species, *Emphytus tarsatus* of Say (Fig. 7). *Nematus* has also nine jointed antennæ. The European currant or gooseberry fly or worm, *Nematus ventricosus*, is said to have been imported from Europe about the year 1860 and arrived in Massachusetts in 1865. At present it does much injury to currant-bushes by destroying the foliage. The eggs are deposited in regular rows along the under side of the leaves, on the middle and larger ribs. Their eggs hatch in about four days, and the larvæ, after destroying the foliage and when ready to change, burrow into the ground, where they spin small silken cocoons, in which they change into pupæ. The first brood of insects appear about July and lays the eggs for the second generation, which pass the winter in the earth as larvæ and pupæ, to reappear as perfect insects the following spring. Thus, there are two broods each season. The larvæ are pale-green, with head, tail, and feet black, and they have numerous black spots regularly arranged around the body. The female insect is of a bright honey-yellow color, with black head; the male has a black thorax. The early changes from the larva state must be extremely rapid, as it is said to feed, molt, and burrow in the ground, all within a period of eight days.

The usual remedy recommended for the destruction of this saw-fly is to strew slacked lime over the bushes (destroying both leaves and fruit), but Dr. Mach, of Salem, recommends a solution of a pound of copper to six gallons of water, sprinkled over the bushes; this blackens the leaves, but is said not to injure them permanently. Carbolate of lime sprinkled over the plants as soon as the worms make their appearance has also been recommended, but white hellebore-root, powdered, dusted over the leaves when moist with dew or rain, or used when mixed with water, and applied either through the rose of a watering-can, or with a garden-syringe, is said to have proved an effectual remedy, and if washed off afterward, before using the fruit, has hitherto proved to be perfectly harmless to mankind. *Nematus ventricosus* is said to be attacked by a parasite *Brachypterus* (*Cryptus*) *micropterus*, also a hymenopterus insect. The larvæ of *Nematus trilineatus* have been reported as destructive to the foliage of the weeping-willow, eating all the leaf except the inner mid-rib. These larvæ have twenty feet and are of a bright-green color, palest at the head and tail, with five rows of black dots down their back, and a larger row of black dots above the feet. They are generally found with their bodies bent up over their backs. The male insects are said to be black on the thorax. Not possessing a specimen of this species, we have figured *Nematus integer* (Fig. 8), an insect of the same family found in this neighborhood.

Pristiphora grossulariæ, or the native currant-worm or saw-fly or worm, differs from the imported species in many respects. The larva, which is 0.50 in length, is of an uniform green color, without the black dotting always found on the imported species, except after the last molt; it also spins its cocoon among twigs and leaves of the bushes on which it feeds, instead of going into the earth. The insects, which are black, appear about two weeks after the last molt; the larvæ are pale-green when young, with black head, but when mature the head becomes pale-yellow or greenish and has a lateral brownish stripe. The same remedies are recommended for this insect as have been mentioned for the foreign currant-worm. Another saw-fly, *Pristiphora identidem*, has been reported as very injurious to the foliage of the cranberry. The larvæ, when first hatched, are of a light or pale yellowish green color and grow darker by age; when fully grown they are 0.30 in length and have a lighter whitish-green stripe running above from head to tail. The cocoon was spun in June, among the rubbish at the bottom of the breeding-box, and the insects appeared in June. The male is of a shiny-black color. The same remedies as recommended for the other saw-flies on currants, &c., will also apply to this insect. Walsh also speaks of another saw-fly, *Pristiphora sycophanta*, as a gnat gall-fly in the *Cecidomyia* (or gall-gnat *Diptera*), inhabiting the willow.

Lophyrus abietis (Fig. 9), or the saw-fly of the pine, has been reported as injurious to the foliage or needles of the pine. The larvæ are gregarious, many of them being found in company together feeding on the leaves of pitch-pine, fir, &c. The larvæ are 0.50 in length, and are of a pale, dirty-gray color, yellowish beneath when young, but become altogether more of a yellowish color when more mature.

The pupæ are formed in small, tough cocoons, spun among the leaves. The males have feathered antennæ, and are black above but brownish beneath; the females are yellowish-brown above, with a short, black stripe on each side of the thorax. Some of the flies appeared in August, but it was stated that probably the greater number remained unchanged until the following spring. Showering with a solution of carbolic acid, petroleum, whale-oil soap, tobacco-water, &c., has been recommended, and Paris green or hellebore would doubtless destroy multitudes should they become very numerous; the Paris green, however, might injure cattle, sheep, &c., if grazing near the trees, and when using any such deleterious substances workmen should always keep to windward so as not to inhale the poisonous dust. Other insects of the same family are reported as injuring the pitch-pine's foliage, such as *Lophyrus pinus-regedis* and others, while *Lophyrus lecontei* is said to prefer the Scotch and Austrian pines. These are all mentioned in Professor Packard's valuable work (Guide to the Study of Insects), a work which ought to be in every agricultural library. The Austrian pine is also reported to be injured by a species of *Lyda*, a kind of saw-fly, the larvæ of which form a silken web filled with castings, forming a mass about six inches in diameter among the leaves. These larvæ have no abdominal legs like the other saw-flies, and only six pectoral feet; they are likewise distinguished by two antennæ-like appendages to the head and two similar appendages to the hind part of the body. A similar insect found in the wild cherry, probably *Lyda serotina* (Fig. 10), a young specimen of which is figured here to show the peculiarity of the form of this worm, and the insect of *Lyda abdominalis* (Fig. 11) is figured to show the full-grown fly. A specimen of *Lyda* in Europe is destroyed by an hymenopterous insect, *Exetastes fulvipes* (Fig. 12). The genus *Cephus*, in Westwood, serves equally to connect the *Tenthredinidæ* with the next family *Uroceridæ*. *Cephus pygmæus* (Fig. 13) of Europe is said to reside in the interior of the stems of wheat, and occasionally commits much injury to the plants. It is figured and mentioned here, as either it or an allied species may yet be discovered here. *Cephus bimaculatus*, Say (Fig. 14), is found here, but its habits have not yet been described. The family of the *Uroceridæ* are popularly known by the common name of "horntails," from the prominent horn-like process on the end of the abdomen of the male; the ovipositor of the female is attached to the middle of the abdomen. Some of these insects are of large size; the larvæ are cylindrical, fleshy grubs, feeding on wood in holes, or burrow; the pupæ are formed in their burrows in thin cocoons formed of silk mingled with refuse gnawings of wood and sawdust. The insect of *Urocerus albicornis* (Fig. 15) is black with the end of the antennæ white, and the legs are black and white. The insect is about one inch in length, and it has been taken on pine trees in July. An allied insect, *Urocerus nigri-*

cornis (Fig. 16), is rather common in some localities; it, however, has black antennæ; the head, thorax, and part of the abdomen are black, but the hinder part of the abdomen and legs are reddish-clay color. The fly itself is nearly an inch in length, and the wings are somewhat smoky. *Urocerus juvencus* of Europe is said to attack firs, and has been reported to do much injury to the trees. The insect of *Xyphidria* obtains its name from its sword-like ovipositor. *Xyphidria albicornis* (Fig. 17), or the white-horned *Xyphidria*, is found on trees of soft wood in August in Massachusetts. The larvæ are reported to bore into trees in a somewhat similar manner to the *Uroceridæ*. In the perfect insect of *Xyphidria* the prothorax is elongated into a neck. The insect is about 0.60 to 0.75 in length, with black head and a narrow white mark around the eyes; the body is also black, with five or six white spots on each side of the abdomen. The female of *Tremex* (*Sirex*) *columba*, or the "pigeon tremex," bores holes by means of her ovipositor in the wood of elm, pear, butternut, &c., in which she deposits her egg. The larvæ are yellowish, about an inch in length, and feed upon the wood. These insects when in the larva-state are frequently destroyed by large *Ichneumon* flies, having very long hair-like ovipositors and appendages. These insects are called *Rhyssa lunator* and *atrata*, and use their ovipositors to bore into the burrows made by the pigeon trimex to deposit their eggs in the larvæ, where they feed upon the juices of the *Tremex* grub. Frequently, however, the *Tremex* gets its ovipositor so far into the wood that it cannot withdraw it, and the insect perishes fastened to the tree-trunk. We have an example of this in the museum, where the dead insect is fastened to a piece of elm wood by its undrawn ovipositor. The *Ichneumon* itself also has frequently been found in the same position, dead, where it has been inserting its ovipositor in the larvæ of the *Tremex* and was unable to withdraw it. *Oryssus hæmorrhoidalis*, or the red-tailed *Oryssus*, is mentioned by Harris. The larvæ bore into the wood of the willow. The insect is 0.60 in length, rough before, but smooth behind. The last three segments of the body are blood-red, hence its name. The wings are clear and transparent, with a smoky, broad transverse band beyond the middle of the first pair.

Oryssus maurus is a very similar insect, but is of a dark or black color, with white on the legs and antennæ like *O. hæmorrhoidalis*. Not having either of these insects in our collection we have figured another European species, *Oryssus cornatus* (Fig. 18), from Westwood.

Insects of the family of the *Cynipidæ*, with a few exceptions (hereafter named), puncture the leaves, limbs, young stems, and roots of various plants and trees with their curiously formed ovipositors and insert an egg in the wound, together with a peculiar irritating fluid, which causes the production of tumors or galls of various sizes, shapes, and colors, many of the galls on our native oaks resembling red or white currants, small apples, or peaches. The interior of many of these galls is of a solid substance which furnishes the food of the young grub when hatched. These grubs live in cavities in the center of these galls, where they change into pupæ, and, when fully matured, eat their way out into the open air as perfect flies. Others, however, eat their way out of the hardened and indurated galls as larvæ and change into pupæ on or in the earth, and then make their final change as flies. One of our largest and most remarkable galls is made by a small fly, *Cynips confluens* (Fig. 19). This gall is of large size and rounded form, somewhat like a small apple, but without the depressions for stem and calyx; it is sometimes two inches in diameter, green and pulpy at first, but when ripe has a hard grayish-brown thin shell, with an interior like sponge, and a woody cocoon or cell in the middle where the larvæ and pupa reside. One of the figures represents the gall as young, the other the gall as old and cut open to show the cell in the middle, and the next of a rose-cutting bee which is frequently found in such situations in Maryland. There are sometimes two broods in one season. *Cynips bicolor* (Fig. 20) is a small black and red gall-fly, which forms a mossy or hairy reddish gall on rose-bushes, the outside of which appears as if covered with a velvety red moss. This gall is sometimes known by the name of "Bedeguar," and was formerly used for medicinal purposes. When on the subject of the gall-flies, it might be well to mention that the gall of commerce is formed by a gall-fly and comes to us in the form of small round balls of a dark color, varying in size. These galls are produced by a small gall-fly, *Cynips quercifolis* (*Diplolepis*) *gallæ tinctoriæ* of Geoffry. The gall-fly pierces the shoot or young boughs of a small oak and deposits an egg in the wound. The larva growing within the gall or excrescence lives in an oval cell in the middle of the gall, changing into a pupa in this cell, and finally emerges into the open air from a hole gnawed through its covering by the insect itself. Those galls are most valued that are without holes; those which have been perforated by the insect are less valued, are gathered later, and are called white galls. Galls are imported principally from Smyrna and Aleppo; they are used in coloring black, and form one of the principal ingredients in making ink. In 1850 upwards of two hundred and seventy tons of oak-gall were brought to the British market, and most probably many of our native galls might be profitably used for dyeing and making ink. Osten Sacken says that if the same gall-fly attacks different oaks may it not in some cases produce different galls, and mentions two varieties of galls on different species of oak producing gall-flies almost identical in shape, form, and color. The rose is also attacked by another gall-fly, *Cynips* (*Rhodites*) *dichlocerus* (Fig. 21), the insect of which produces a prickly irregular swelling on the stem; it is, however, said to be destroyed by a chalcid parasite hymenopterous insect, *Callimone chrysochroa.*

Gall-flies belonging to the genus *Rhodites* are found on the rose-bushes, and Osten Sacken enumerates eight galls made by *Cynipidæ* on the different rose-bushes of this country. If these rose-galls should increase to such an extent as to become injurious to the plants, they can readily be cut off and burned as soon as they appear on the bushes; but when so numerous as they appear on the oaks, it would be almost impossible to destroy them unless they should be gathered and some use found for them. *Biarrhiza* is a wingless species of *Cynips*, which probably forms galls on the roots of oak. *Biarrhiza niger* of Fitch is very small, being .008 in length and of a black color.

Figites is said by Westwood to be parasitical upon the larva of a *Syrphus*, or two-winged fly, in Europe, and another of these insects is said to destroy the insects that injure the olive. The insects of the genus *Figites* are concluded to be true internal parasites, and the males have feathered antennæ. One of them is said to be parasitic in the larva of *Sarcophaga*, a flesh-fly. *Allotria victries* of Europe, another allied insect, is also parasitic, having been detected in the act of laying its eggs in the body of a rose-plant louse, or *Aphis.*

In this family, *Cynipidæ* (West.), will be found a very singularly formed insect, *Ibalia*, the abdomen of which is very much compressed and shaped like a saber; the hind legs are disproportionately long. It was very rare, only two species of this genus having been mentioned by Westwood in Europe. He, however, speaks of a third species from Georgia which may probably be *Ibalia maculipennis* (Fig. 22), and which was said to be from the United States.

Some of the family of the *Evanidæ* are very singularly formed, the head being of the usual size, the thorax is very large and thick, while the abdomen is exceedingly small and insignificant, being very short and compressed. They are said to be parasitic, living in the eggs of cockroaches. We have figured *Evania appendigaster* (Fig. 23), which is mentioned by Westwood as feeding on cockroaches.

Packard has taken both pupa and insect of *Evania lævigata* from the eggs of a cockroach, thus proving what Westwood had previously stated. *Fœnus jaculator*, of Europe, infests the nests of a species of *Crabo*, laying its eggs in the larvæ. The insect figured below as *Fœnus irritator* (Fig. 24) was sent by a noted entomologist, and therefore has been figured as giving some idea of the figure and form of the genus *Fœnus*. *F. jaculator*, of Europe, deposits its eggs in the *Crabronidæ*.

The female of *Pelecinus polycerator* (Fig. 25) is a very singularly formed insect, the body being extremely elongated and thin; hence its common name of *needle Ichneumon*. The abdomen is very much attenuated, black, and is usually carried in a curved form. The male is extremely rare, and its abdomen is said to be short and clavate; it is not definitely known upon what the insect feeds, although the female is tolerably abundant in Maryland. *Aulacades* of Cresson is said to form a close connecting-link between the minute *Ichneumon* and the *Evanidæ*. *A. nigriventrus* is figured in Packard.

Ichneumon larvæ are parasitical in the bodies of caterpillars and other insects, where their grubs feed in the bodies of other larvæ or pupæ, consuming the fatty matter and eventually killing their hosts. The larvæ of the *Ichneumon* flies are soft, footless grubs. The eggs are laid either in or on the insects they infest, and when hatched penetrate into the interior, where, as before stated, they feed upon the fatty substance only, and carefully avoid the vital parts until the grubs are nearly fully grown. The caterpillar or larva injured at first shows no sign of its internal parasite, but appears in perfect health, eating and moving about as usual, until later, when it appears lifeless, and dies, either in the larva or pupa state. The pupa of the *Ichneumon* fly sometimes is formed in the earth, in cocoon, in the body of the injured pupa itself, and eats its way out of the outer hardened skin as a perfect *Ichneumon* fly. The ovipositor of the female insect is frequently very long and bridle-shaped, protected by a sheath, in order to be enabled to thrust their eggs into the holes or chinks where their victims hide.

Ichneumon suturalis (Fig. 26) is said to destroy the army-worm, *Leucania unipuncta*. Even beetles and the other orders of insects do not escape from the *Ichneumon* flies, and the whole family of the *Ichneumonidæ* may be counted as among the best friends of the horticulturist and farmer.

We have figured *Ichneumon grandis* (Fig. 27) as a large and well developed species that was taken in Maryland. *Trogus exesorius* (Fig. 28), another *Ichneumon* fly, is a very common species, and feeds in the caterpillar of *Papilio asterias*, the black and yellow "swallow-tailed" butter fly, so common in our gardens, the caterpillar of which, under the name of the parsley or celery worm, does so much injury to almost all the cruciferous plants, such as parsnip, fennel, dill, &c. The caterpillars of these worms are green, bounded with black and spotted with orange dots. These *Ichneumon* flies must be very useful, as they destroy multitudes of these noxious and disagreeable-smelling caterpillars. The insect of *Trogus exesorius* is of a clay color, having clouded, dark-colored wings. *Cryptus compunctor*, of Europe, deposits her eggs in the pupæ of butterflies, according to Westwood. *Cryptus inquisitor* (Fig. 29) destroys the *Thyri-*

dopteryx ephemeræformis, the hang or drop worm, and has been raised from its cases or hanging nests on the cedars in the Smithsonian grounds. *Thrygadenon* has its legs and antennæ somewhat thickened and simple; the abdomen is petiolated, and the ovipositor is exserted and somewhat long. Dr. Fitch states that five of these larvæ came out of a cocoon made by *Tolype* (*Planosa*) *laricis*, or the moth of the larch-cheater, each of them having gnawed a round hole through its cocoon. *Hemiteles*, a small *Ichneumon* fly, is recorded as having been raised from eggs of *Clisiocampa americana*, or the lackey caterpillar of Harris. They are also said to be parasitic in spiders' nests, in Europe, and Ratzeburg gives a list of fourteen ichneumous parasites in spiders; he also says that *Hemiteles fulvipes* (Fig. 30), of Europe, is parasitic in *Microgaster nemorum* of Europe, which is also a very minute hymenopterous insect like itself. *Pezomachus minimus*, of Walsh, is also a very small insect. It is said to be apterous, or wingless, and has been reported destroying *Lucania unipuncta*, or the Western army-worm or caterpillar. When about to change into the chrysalis they eat small holes through the skin of their victims, out of which they emerge and spin small cocoons on the sides of the dying caterpillars. These are symmetrically arranged side by side and enveloped in a floss. *Pezomachus agilis* (Fig. 31), of Europe, as figured below from Ratzeburg, is given, so that our readers may form some idea of the size and form of these insects.

Rhyssa (*Pimpla*) *lunator* (Fig. 32) is so called from the crescent-like marks across the body. The ovipositor of the female is extraordinarily long and bristle-formed, and when the insect is depositing its egg is bent downward so that its point touches the desired spot. The two sheaths of the ovipositor do not enter the tree, but pass down each side of the ovipositor to give it strength, and are held in position and stiffened by the hinder thighs, through which they pass. In this way the ovipositor is sometimes passed four or five inches into the solid wood, and sometimes becomes so firmly fastened to the tree that the insect cannot withdraw its ovipositor, but dies with it fast in the wood. The male *Rhyssa* (*Pimpla*) *lunator* (Fig. 33) is entirely different from the female in size and shape, being much shorter-bodied yet more slender in form. These insects are parasitic in habits, and feed as larva upon the larvæ of the pigeon *Tremex* or other wood-boring insects.

Rhyssa (*Pimpla*) *atrata* resembles *R. lunator* in form and habits, but is of a dark or black color, with clouded wings. *Pimpla pedalis* (Fig. 34) of Cresson is parasitic on *Clisiocampa* (lepidoptera); its ovipositor is half the length of its abdomen. *Exetastes fulvipes* (Fig. 35) of Europe is said by Ratzeburg to be parasitic in a *Lyda*, a hymenopterous insect mentioned in a former part of this report. In Ophion the antennæ are as long as the body, the abdomen is compressed, and the insects are generally of a honey-yellow color. The female of *Ophion macrurum* (Fig. 36) is reported to lay her eggs on the skin of the caterpillar of *Telea* (*Attacus*) *polyphemus*, one of our largest moths, and the larvæ or grubs hatched from these feed upon the fatty portions of the worm, avoiding the vital parts until the last, when the infested caterpillar has spun its cocoon. The parasitic larva then attacks the rest of it, and eventually kills it, when it leaves its dead victim and spins an oval dark-brown case or cocoon in which it changes into a pupa and eats its way out in the following spring.

The larvæ of another parasite, *Ophion bilineatus* (Fig. 37), destroys *Spilosoma virginica*, a medium-sized white moth or miller, with black dots on its wings, while *O. purgata*, very common in Maryland, is destructive to *Leucania unipuncta*, or an army-worm feeding on grass, grain, &c.

Porizon conotracheli, or the curculio parasite of Riley, is reported as destroying the plum weevil, or curculio, *Conotrachelus nenuphar*, a small beetle very injurious to the plum and other fruits. The larvæ destroy the grubs of this destructive beetle. The cocoon is said to be more yellow than that of *Sigalphus curculionis*, another hymenopterous parasite to be described hereafter as destroying the plum-curculio. The perfect fly of the *Porizon* is reported not to appear in the winged state until the following spring. The insect is from 0.28 to 0.32 in alar expanse, and 0.18 to 0.22 in length of body; the head is black, the abdomen rufous, the peduncle black, and the legs are pale yellowish. *Sigalphus curculionis*, another small ichneumon or parasitic four-winged fly, is reported to be also a true parasite on the plum-curculio. This insect is somewhat allied to *Bracon*. The larvæ, after destroying the larvæ or grubs of the curculio, incloses itself in a small, tough, yellowish cocoon of silk, in which it changes into a pupa, and about the time the true curculio should appear the insect gnaws a hole through its cocoon, and appears as a small four-winged black fly. Mr. Riley estimated one year that three-fourths of the early-developed curculio larvæ were destroyed by this parasite in the neighborhood of Saint Louis. The insect is also reported to attack the small plum-moths. The female fly is 0.15 to 0.16 in length, and in alar expanse 0.30. The insect is black in color; the legs are pale and rufous, with the upper part of the tibiæ and tarsi dusky. A small parasitic four-winged fly, *Bracon palpebrator* (Fig. 38), is mentioned by Ratzeburg as destroying the *Curculio notatus* of Europe, and a small fly with black head and thorax, red abdomen and clouded wings, and three long setæ or bristles at the end of its abdomen as ovipositor and appendages. *Lamprosoma americana* (Fig. 39) was taken abundantly on wood-piles in Washington, where they were busily employed in depositing their eggs in passages bored by other wood-eating insects.

Another very small four-winged fly, allied to *Bracon* (Fig. 40), was hatched out of small parchment-like cocoons fitting into the passages made by other wood-boring insects, and spun in the slender galleries where the rightful tenants had previously been destroyed.

Rogas differs from *Bracon* in having the three first abdominal rings long, forming a slender *petioli*, according to Mr. Packard, but as we possess no specimen the figure cannot be given here. *Microgaster* and its allies contain four-winged parasitic flies, very beneficial to the farmer, as they destroy myriads of other noxious insects. *Microgaster nephoptericis* is reported as parasitic in a nephopteryx, a lepidopterous insect or moth, but it is found also in the cells of humble bees. Another Microgaster has been found in the caterpillar of *Chœrocampa* (*Sphinx*) *pampinatrix*, the hog-caterpillar of the grape-vine; another destroys the larvæ of the army-worm, of butterflies, moths, and even spiders themselves. *Microgaster congregata* (Fig. 41) destroys the caterpillar of the potato, tomato, and tobacco worms—*Macrosita* (*Sphinx*) *quinquemaculata* and *Carolina*. The minute dark-colored, almost black, female fly first punctures the skin of these caterpillars in many places and deposits her eggs in these punctures. The small footless grubs hatched from their eggs feed upon the internal fatty substances of the caterpillars until they attain full growth, when they eat their way out of the skin and form small, oval, white egg-like cocoons on the outside and fastened to the dying tobacco-worm. The perfect flies appear in a few weeks, and sometimes much earlier, especially in hot summer weather. Many caterpillars are frequently seen almost perfectly covered with these small egg-like cocoons, and attract much attention. When caterpillars are found thus infested with egg-like cocoons they should not be killed but carefully preserved, as, if protected, they will produce hundreds of these flies which destroy hundreds of the caterpillars feeding on potatoes, tomatoes, and tobacco. The figure given here represents only a very small tobacco-worm, as a full-sized figure would take up too much space and would be no better than a smaller caterpillar.

Alysia rubiceps (Fig. 42) of Europe is mentioned by Ratzeburg as being parasitic in the body of a small beetle *Magdalus*, while *Praon viburnaphis* is mentioned by Tiber as preying on the aphis or plant-louse of the high-bush cranberry. This insect is only 0.15 in alar expanse; it is black in color, and has a short abdominal pedicel; the anterior legs are of a wax yellow, and the wings are hyaline.

Trioxys is also mentioned by Fitch as destroying plant-lice on the willow, poplar, cherry, and other trees. The *Aphidius* or *Trioxys* of the cherry is mentioned as having a somewhat singular habit; the larvæ, after devouring the interior of the body of the aphis, spins a thin cocoon between the dead body and the leaf. The insect is only 0.07 in length, and the antennæ are almost as long as the body; the insect is black; the palpi and legs are pale yellow-brown.

A parasitic insect attacks the *Hippodamia* (*Coccinella*) *maculata* (Fig. 43) or spotted lady-bird in a very similar manner, and was taken in Maryland. The larvæ of *Aphidius* also destroy plant-lice (*Aphides*.) The female fly deposits a single egg, by means of her ovipositor, in a plant-louse where the larva or grub when hatched devours the interior of the insect; the pupa is formed in the hollow shell or hardened skin, and, when ready to change, the perfect four-winged minute fly emerges out of a round hole gnawed through the skin, and which sometimes resembles a circular lid or trap-door. The plant-lice attacked by these parasites are readily known by their swollen form and brown or darker appearance. When a plant-louse has been stung by the parasite, it is said to leave the rest of the crowd, swell, and fix its claws in the leaf. It eventually dries up, with the skin very much swollen and the living parasite within its hollow body.

Aphidius triticaphis (Fig. 44) destroys the plant-lice on the wheat. *A. avenæ* attacks the oat-aphis of Europe, and in short almost all plants attacked by plant-lice have their peculiar parasitic small aphidians, or other fly or insect, to destroy them and thus preserve the crops, which would otherwise be totally ruined by the plant-lice, which multiply so rapidly, as witness the lice on hops, cabbage, fruit trees, and almost every other vegetable production.

Aphelinus (Fig. 45) is a small parasitic fly, which was found destroying *Chrysopa*, a neuropterous insect, which was bred in Maryland and formed a cocoon on a small shrub.

Chalcis (*Aphelinus*) *mytilaspis* is mentioned by Le Baron as destroying the apple bark-louse. In Europe a *Chalcis* is reported by Westwood to be parasitic in the eggs of the *nantis* or rear-horse. Another destroys the eggs of *Œdipoda carolina*, a species of grasshopper. Three species lay their eggs in the body of the caterpillar of *Ceratina* (lepidoptera), and emerge from the larva and pupa skin often in great numbers. According to Dr. Packard, another insect of this genus destroys the *Cecidomyia*, or gnat of the cranberry, and *Chalcis maria* is parasitic on *Telea polyphemus* and *Platysamia cecropia*. These insects are very numerous, forty-seven having been taken out of a cocoon of a *Polyphemus*, of which twenty-three were females.

Chalcis albifrons is reported to destroy *Pezomachns*, a small parasitic four-winged fly, before mentioned, and which itself is said to destroy *Leucania imipuncta*, or the army-worm, and another unnamed species is said to prey on *Ichneumon unifasciatorius*, which destroys *Acronycta* *oblinita*, a moth or miller. These flies are said by Mr. Riley to be very minute and of a steel blue color, with honey yellow legs, and to issue in great numbers through very minute holes in the caterpillars' skins. These facts prove that many of the parasites preying upon insects are themselves preyed upon by other insects as ravenous as themselves.

Chalcis flavipes (Fig 46) is a small insect, black in color, of a rather stout form, and having very swollen hind black thighs, with a yellow mark near the knee. Some of these are capable of springing like fleas when disturbed.

Eurytoma (*Isosoma*) *hordei* (Fig. 47) the joint-worm, or barley-straw insect, is sometimes exceedingly destructive to the crops of wheat, barley, &c., the losses sometimes amounting to two-thirds of the whole crop. It was very destructive in Virginia several years ago, but we have not received many complaints about its ravages lately. The injury to the plants is caused by the abstraction of the sap from the ear, in order to form the swelling or gall, and, by the large amount of sap consumed by the larva, causing the deformity in the stem.

The larvæ of this insect reside in woody swellings or galls in the barley or wheat straw; the tumor or gall being generally found in a joint, or very near it, gives the insect the local name of joint-worm. This irregular swelling or collection of knots contains several small cells, varying from six to ten in number, each containing a single grub or larva. In a short time, when the larva has consumed all the sap it requires as food, the pupa is formed in the same cell and eventually the perfect insect gnaws its way out of the swelling and emerges as a minute black fly to deposit its eggs in other plants. This occurs in February, March, or May, in Virginia.

The larva is about one-eighth of an inch in length, of a pale-yellow color, and heavy dark-brown jaws. The fly is about 0.12 or 0.13 in length, of a black color with a smooth hind body; the thighs, shanks, and claw joints are blackish, while the knees and other joints are pale yellow. Mr. Walsh once thought that this injury to the crops was caused by a gall-gnat, two-winged fly (*Cecidomyia*), and that the insect now known as the joint-worm was merely a parasitic fly that destroyed the cecidomyia. To this, however, we must say that although hundreds of stalks were closely examined we never found a cecidomyia larva, pupa, or insect remains in the knotty swellings containing the *Isosoma*.

It is true other insects were discovered, such as *Semiotellus*, but these proved to be parasites of the *I. hordei* itself. It is, however, true that the genus *Eurytoma* (or *Isosoma*) contains generally parasitic insects, Mr. Walsh enumerating five species alone that are parasitic in twenty-four different galls. *Eurytoma flavipes*, or the yellow barley-fly of Fitch, differs merely from the *E. hordei* by having yellow legs and antennæ, and by the antennæ of the female not being surrounded by whorls of hairs.

E. secalis, or the rye-joint worm which is named the Rye-joint worm, differs by having the hind pair of shanks dull yellow; and *E. fulvipes*, which also differs slightly in several minor particulars, are enumerated as distinct species; yet may not these apparent differences be caused by variety of food or habit of the above-named joint-worms, as their habits are almost precisely the same as the Virginia species *E. hordei*? These insects are very subject to be destroyed by small parasitic four-winged flies, *Semiotellus*, &c. In order to destroy these insects it has been recommended to burn all the stubble off the ground before the following summer or as soon as possible after the harvest is in, and to burn all the tailings of the grain and the refuse straw after thrashing, as the insect does not appear to be killed by frost or snow, and has been produced abundantly from straw made into manure by being rotted in the stable and then thrown on the manure-heap and exposed all winter.

Isosoma vitis, or the grape-seed maggot, is reported as destroying the fruit of the grape-vine. Mr. Saunders states that this insect is also in Canada, where it appears from the middle of July to August, and affected the Clinton and Delaware grape. The female insect is very small, being only 0.10 in length and the male 0.6; they are of a black color, with pale brown and black legs. The eggs are deposited on the skin of the grape. The larva punctures it and works its way to the middle of the fruit, and then enters the seed while young and soft and eats its interior; the larva then remains in the seed and changes into the perfect fly in July and August. The remedy recommended for its destruction is to destroy all shriveled fruits as soon as observed.

Leucospis affinis (Fig. 48) is a medium-sized chalcis, remarkable for having its ovipositor laid upon the upper surface of its abdomen, which is spotted and banded with yellow resembling a wasp. Say observed *Leucospis affinis* running actively over the surface of a rafter in a barn, busily feeling with its antennæ for a proper situation in which to deposit its eggs; having found a suitable place, the insect, after some exertion, suddenly disengaged the oviduct from the groove and valves and gradually thrust the instrument into the wood nearly to its base. Then having remained a short time at rest, probably in order to produce the egg, the oviduct was withdrawn, adjusted into its dorsal groove, and the insect proceeded again as before in search of another spot suitable for its purpose. Say, however, could not ascertain the kind of larva within the wood that received these eggs. The insects of *Leucospis fraterna* of Say, a cloudy allied species, are said to be obtained chiefly on blossoms of the parsnip. Westwood states that the anterior wings of a Leucospis are folded longitudinally when at rest. *Leucospis poeyi*, of Cuba, is stated by Packard to be parasitic in the nest of Megachile, a wild bee. *L. dorsigera*, of Europe, is said to deposit its eggs in the nests of a mason bee, and *L. gigas* in the nests of wasps.

Macroglenus penetrans (Fig. 49) is said to be parasitic in *Cecidomyia* (*Diplosis*) *tritici* the wheat-midge in Europe. This insect is figured from Curtis, as a similar or allied insect may yet be found in our wheat-fields, and ought to be recognized by the farmers as a beneficial insect. *Torymus harrisii* is reported by Dr. Fitch to be parasitic in the *Eurytoma* (*Isosoma*) *hordei*. The insect deposits its eggs in the larvæ, and the grub hatched from them devours the interiors, thus proving a friend to the farmer. Another Torymus feeds also in the nests of wild bees, *Osmia*, &c. Ratzeburg also mentions a Torymus in Europe which is said to be parasitic in a Tortrix or small moth, and yet others that destroy a *Bombyx* or moth and *Tenthredo* and probably *Cryptus*, an hymenopterous insect. *Torymus obsoletus* (Fig. 50) is figured from Ratzeburg. *Perelampis* is also a chalcid parasite mentioned by Dr. Packard; the antennæ are short and jointed, and when at rest lie in a deep frontal furrow; the head is large, abdomen contracted and slightly peduncled. The ovipositor is concealed, and the insect is of sherry metallic tints. *Perilampis triangularis* (Fig. 51) found in Maryland is here figured. Westwood states that in Pteromalus the femora slender, the ovipositor concealed or securely exserted, and the antennæ are 13-jointed with the third and fourth joints annular, and the fifth of moderate size. These small insects are exceedingly useful by destroying many noxious insects of several orders. They frequently lay their eggs in the eggs of butterflies, *Pteromalus vanessæ* being parasitic in *Vanessa antiopa*, a common butterfly.

P. clisiocampæ destroy clisiocampa, a tent-caterpillar. One species in Europe, *P. pini*, is reported to be parasitic in *Curculio notatus*, a European beetle, while another in the United States feeds in the larvæ of *Erytoma* (*Isosoma*) *hordei*, or the destructive joint-worm. *Pteromalus micans* (Fig. 52) of Europe is said by Curtis to destroy *Chlorops*, or two-winged fly, injurious to grain. *Pteromalus puparum* is exceedingly useful in the United States to gardeners, as it destroys *Pieris rapæ*, or the imported white cabbage butterfly, lately so injurious to the cabbage-crop of the Northern and Eastern States. The whole stock of eggs are reported to be deposited in the newly-hatched pupæ of *Pieris rapæ;* these hatch out into minute grubs or maggots that destroy the pupa or chrysalis and then reappear as minute four-winged flies, to again deposit their eggs in other insects. A species of *Pteromalus* is said by Westwood to destroy the egg capsules of *Blatta americana* or cockroach, and Ratzeburg mentions another as parasitic in spiders. This insect, *Pteromalus*, is very useful to farmers by destroying many of the small enemies of his crops, and should be prized accordingly as one of his friends. A species of *Eulaphus* with simple antennæ in both sexes is said by Westwood to destroy cockroaches, not less than seventy individuals having once burst forth from the egg capsule of *Blatta americana*, the eggs of which must have been deposited during the voyage. One species of *Eulaphus* is said also to be parasitic in a magdalis or beetle in Europe. The *Proctotrupidæ* consist of very small insects having their fore wings either destitute of or having very few veins; they are slenderer than the *Chalcididæ* in form, and generally parasitic in the eggs of other insects, and destroy gall and fungus-eating flies. One species is described as destroying *Lasiopteryx vitis*, a dipterous two-winged gall insect on the grape-vine. *Diapria cecidomyiarum* of Europe, another of the *Proclotrupidæ*, is parasitic in the larva of *Cecidomyia artemesiæ*, or the Artemesia gnat. In *Ceraphron* the abdomen has a very short pedicel. *Ceraphron destructor* was said by Harris to be very useful to farmers by destroying the larvæ of the Hessian fly, *Cecidomyia destructor*. The eggs are deposited in June in the maggot of the Hessian fly, and the perfect fly works its way out later in the season. This insect is said by entomological authorities not to be truly a *Ceraphron* or *Eurytoma*, but comes very near *Pteromalus* or *Rhaphiteles*. Insects of the genus *Teleas* are also very minute egg parasites; one of them is reported to destroy the eggs of a water-boatman. *Gerris* and *T. linnaei* is parasitic in the eggs of *Bombycidæ* (moths or millers). In Teleas the antennæ are clubbed and the legs are adapted for leaping.

Teleas læviusculus (Fig. 53) is figured from Ratzeburg to give some idea of the form and size of this insect. Platygaster, another of the *Proctotrupidæ*, has the abdomen often flattened. The antennæ are ten-jointed and club-formed; in the female the wings are without cells or veins, and the legs are not formed for leaping, as in *Teleas*. The insect is very minute, and the eggs are deposited in the eggs of the Hessian fly (*Cecidomyia destructor*). Notwithstanding these internal parasites, the egg of the Hessian fly hatches as usual, but the larva is unable to go through its usual transformations to the perfect fly, and dies after taking the flax-seed form. Meanwhile the intestinal foes are hatched, come to their growth, spin themselves little brown cocoons within the skins of their victims, and in due time eat their way out as perfect winged insects. When the larva is about to change to the pupa it assumes the form of a flax-seed case, in which, when not killed by the parasite, a pupa is formed, and in due time a four-winged minute fly. These flaxseed-shaped cases are generally found between the sheath and straw at or near the bottom of the infested plants.

Another Platygaster destroys the eggs of the canker-worm (*Anisopteryx vernata*), the American tent-caterpillar (*Clisiocampa americana*), and one is recorded as destroying a scale insect or *Coccus* (*Lecanium*). *Platygaster tipulæ* (Fig. 54), from Europe, parasite in a *Tipulæ*. A two-winged fly is here figured from Ratzeburg to show the size and form of one of these insects, as we have no authenticated specimen in our entomological collection. In *Inostemma* the club of the antenna is clavate in the female, and the abdomen is furnished with a horn on the last segment of the body.

Platygaster inserens (Fig. 55) is also exceedingly minute, and in Europe is supposed to destroy the eggs of the wheat-midge, *Cecidomyia* (*Diplosis*) *tritici*. The family *Chrysididæ* of Leach, usually called cuckoo-flies, contains insects of small or moderate size, and of brilliant metallic, blue, green, and ruby tints. They obtain their common name of cuckoo-flies from their habit of depositing their eggs, not in the bodies of other insects, but in the nests of different fossorial bees and other *Hymenoptera*, where they starve out the original proprietors by devouring their store of food, and are what Mr. Walsh correctly called gnat-flies. Other authorities, however, state that they are truly parasitical and feed upon the bodies of other larvæ. *Chrysis bella* is said to be parasitical on *Eumenes fraterna*, or the potter wasp.

Westwood states that in *Chrysis* the abdomen appears to consist of only three segments, and its extremity is terminated by a series of denticulations. The ovipositor of some of the female *Chrysididæ* forms a long, large-jointed sting, which, however, is said not to possess a poison-bag. *Chrysis nitidula* (Fig. 56) was taken in Maryland. *Chrysis hilaris* is mentioned by Dr. Packard as being a short, thick, bluish-green species found in New England, 0.32 in length, with its abdomen hollowed out beneath and tip broad and square. These insects are also sometimes called golden or ruby tailed flies, from the color of some of the species, and the abdomen being concave beneath, if disturbed the insect is able to roll itself up into a ball like a hedgehog, presenting only its hard back and wings to any other insect attempting to assail it. Another genus is *Hedychrum* of Latreille, in which the body is semi-circular or nearly hemispheric, and the thorax broadly truncate in front. Insects of this genus have been recorded in Europe as depositing their eggs in galls in the nest of a megachili or wild bee, and in *P. sen*, a hymenopterous insect hereafter spoken of. An insect thought to be *Hedychrum Zimmermanni* (Fig. 57) of Maryland is here figured.

The second section of the *Hymenoptera* of Westwood is called *Aculeata* by Latreille, and is distinguished by the females (and neuters of such species as live in societies) having the organ of oviposition converted into a sting connected with poisonous glands in both females and neuters. These organs have been subdivided into two groups, viz., those living in societies having individuals of the neuter sex, and those solitary in habits and consisting only of males and females. Westwood in his classification commences with the *Crabronidæ*, the wood or sand wasps. These insects are of moderate size and resemble wasps in appearance and coloration. They are generally of very active habits. Dr. Packard commences the *Crabronidæ* with *Philanthus apivorus* of Europe, an insect which provisions its nest with honey-bees, and, therefore, may be considered as injurious by those individuals who raise bees for honey. He afterward mentions a *Cerceris* in Europe which also is known to store its nest with bees and also with the larvæ of *Curculionidæ* and *Buprestidæ* (coleopterous insect), thirty nests of *C. bupresticida* having been unearthed in a single field, which contained ten species of *Buprestidæ* comprising four hundred individuals. *Cerceris desertæ* is here figured as being one of the most common species found in Maryland (Fig. 58). In *Crabro* the head is large and nearly square, as viewed from above, and the mandibles have the outer edge but slightly curved and not with deep incisions as in the *Larridæ*. According to Westwood, one species of *Crabro* forms its nest in partially decayed wood, and in one stick. Mr. Walsh found several dozens of nests of a small species of wood-wasps, from which, the ensuing summer, he bred a dozen of the perfect insect. Another species is said to provision its nest with the bodies of plant-lice (*Aphides*) in Europe. *Crabro sexmaculatus* burrows in decayed wood in June, and another species was seen boring into a post. *Crabro architectus* (Fig. 59) of Say is here figured *Crabro;* in Europe, bores into palings, posts, willow stumps, &c., and provisions its nest with a small *Pyralis* or moth feeding on oaks; another on two-winged flies, *Anthomyia pluvialis*, &c., and on blue-bottle flies, &c. *Psen* is regarded by Dr. Packard as merely a degraded *Cerceris*, and in Europe some of them appear to nidificate in sand; others are wood-burrowers, and provision their cells with homopterous insects, *Aphides*, &c.

In the *Crabronidæ* Dr. Packard includes in his work *Rhopalum pedicellatum*, bred from the stems of rose, cocoras, japonica, and spirea; *Stigma fraterna* burrows in the stems of syringa; *Cremonus inornatus* burrows in elder, and *Passalœcus mandibularis*, burrows in stems of alder and syringa. The subfamily of *Nyssonidæ* of Leach, in Westwood, have the abdomen of an ovoid conic or conical form, being broadest at the base and never attached to the thorax by a long pedicel; the head is moderate in size, antennæ filiform, and mandibles not strongly notched on the outside at the base.

Trypoxylon is distinguished by its reniform eyes, its long narrow peduncled abdomen. The mandibles are toothless. One species in Europe destroys spiders. *Trypoxylon frigidum* lives in the stems of syringa. *Trypoxylon clavatum*, here figured (Fig. 60), was taken in Maryland. In Europe a species was detected frequenting holes occupied by a species of *Odynerus*, a hymenopterous insect, carrying a small round ball or pellet consisting of about fifty aphides or plant-lice. The genus *Goryles* resembles closely the genus *Odynerus;* the abdomen is elongate ovate, and the mandibles are two-toothed. The insects frequent flowers of the spirea late in summer, and in Europe are found on umbelliferous plants in summer; in Europe one was observed carrying off the larva of an *Aphrophora* or spittle insect, after trying to dislodge another larva from the drops of froth made by the insect. *Mellinus bimaculatus* was taken in Maryland on flowers in autumn, and is a small, slight, wasp-like insect of a black color, with a small yellow spot on each side of its abdomen. *Osybelus emarginatus* (Fig. 61) was also taken on flowers about the same time, and is reported to be common on the Virginia creeper; it is said to have two oval membranous appendages to the metathorax. In Europe the food of an *Osybelus* consists of *Diptera* (two-winged flies), and Westwood states that it has a peculiar way of carrying its prey while opening the mouth of its burrow or forming a new one. It uses its two fore legs in making its hole with great rapidity, moving them alternately and scratching a burrow sufficiently deep to cover itself.

Stizus speciosus very much resembles an immense wasp or hornet, and is very abundant on the Agricultural grounds in Washington, where they dig deep holes in the ground, in which they bury locusts, or more properly harvest-flies (*Cicada*). These insects are armed with very powerful curved stings, and are commonly but improperly known as hornets; they are also called digger-wasps, and in Texas "horse-guards." They are very rapacious in habits, paralyzing the locusts or *Cicadas* or large grasshoppers with their powerful stings, and then carrying their victims off to provision their nests and serve as food for their young grubs or larvæ when hatched. The insects themselves have been seen feeding on the sap of trees. This insect measures more than an inch in length. The head, thorax, and legs are of a dark-brown color, and the abdomen is black with broken bands of yellow. Mr. Walsh gave a very good description of the habits of *Stizus grandis*, a similar but larger insect than the *S. speciosus*, which will apply very well to our species. The "insect digs a hole in the ground as a nest; it then catches a locust (*Cicada*), stings it just enough to stupefy it, but not enough to kill, and drags it into the hole as food for its future young. It then deposits a single egg in the nest and closes up the hole with earth, then flies off to repeat the process until its stock of eggs is exhausted. The soft, white, legless larva when hatched out, gradually devours the body of the living locust, and when full-fed it spins a membranous cocoon in which it passes the winter, and comes out as a perfect wasp the next spring." We have frequently seen this insect in the act of carrying the yet living body of the locust (*Cicada*) and burying it in holes in the departmental grounds. Westwood states that *Stizus* appears to form a connecting link between the *Bembycidæ* and the *Scoliidæ*, mentioned afterward.

The family of the *Larridæ* is of small extent, and the species are of small or moderate size. *Larridæ argentata*, a small wasp-shaped insect, is covered with a silver pile. It is a slender form with short, nearly unarmed legs. A specimen was taken near the agricultural college in Maryland (Fig. 62), busily employed in dragging a still living but partially paralyzed cricket (which was much larger than itself) to its nest. Some of this family are said to frequent the Asclepius flowers, the pollen of which is sometimes found adhering to their feet. This fact we ourselves have observed in several instances when examining insects frequenting this plant. Westwood states that there are no British species of *Bembex*, but observes that the family of the *Bembycidæ* contains insects of moderate size, some few, however, being nearly as large as any known *Hymenoptera*, and that they generally are inhabitants of hot climates. The females burrow in the sand and bury various species of *Diptera* (two winged flies), *Syrphidæ*, *Muscidæ*, &c., depositing their eggs in them, and when a sufficient store has been collected the parent closes the cell with earth.

In Europe, *Bembex* is subject to the parasitic attacks of *Panorpes carmea* and *Toxophora*, a dipterous insect. *Bembex larsala*, according to Latreille, provisions its nest with bee-flies, *Bombylii* (two-winged flies). *Bembex fasciatus*, sometim. s called the bald-faced hornet, is reported to carry off and destroy *Musca cæsar*, a flesh-fly; it also catches common house-flies. The *Bembycidæ* have large heads, flattened bodies, and resemble *Syrphidæ* (two-winged flies), in coloration. *Bembex fasciata* (Fig. 63) was taken in Maryland on flowers, and is here figured; it is said to be very swift in flight, and is abundantly found in sandy places. Another insect of this family is *Monedula*, which, according to Dr. Packard, differs from *Bembex* by having a more slender body, more clovate antennæ, very obtuse labrum, and is more gayly spotted. *Monedula ventralis* (Fig. 64) here figured was taken in Maryland in autumn.

The family *Sphegidæ* are distinguished by having the collar laterally dilated and extending as far as the base of the wings; some of them are among the largest of the *Hymenoptera*. They are restless and active, and their sting is very powerful, paralyzing the insects with which they provision their nests without killing them outright, thus keeping a supply of fresh food for the use of their larvæ. Some of this family make their nests in sand, burrowing into it with their fossorial fore feet, while others build their nests, or rather cells, with mud, fastening them on walls, rafters, and loose boards. The genus *Pompilus* has the collar transversely or longitudinally square, the abdomen more or less oval and attached to the thorax by a very short pedicel or foot-stalk. The species *Pomphilus formosus* is known in Texas by the common name of the Tarantula killer, from its habit of carrying off and killing the large spider commonly (but erroneously) known as the Tarantula (*Mygale hentzii*), which is found in that State.

After depositing an egg in the body of the spider and burying it in the earth several inches in depth, it fills up the hole and leaves the egg to be hatched by the heat of the sun. During the summer this insect feeds on the flowers of the Virginia Creeper and Asclepias—milk or silk weed. These insects are generally black or of a deep blue color, with smoky or reddish wings and sometimes a reddish band on the abdomen, like the insect figured, *Pompilus tropicus* (Fig. 65). Westwood states that some European species also destroy ants as well as spiders. The genus *Cerapales* has a short abdomen, and the hind legs are very long. These insects have been supposed to be guest flies, or parasitic, feeding in the nests of other fossorial or earth-digging species. Abbott, however, figures one in Georgia attacking a spider. *Ceropales ruficollis* is said to have been bred from the mud-nest of Agenia. *Ceropales bipunctata* (Fig. 66) is here figured, and was taken in Maryland; its body and legs are black, while the hind thighs are of a red or orange-clay color. *Pelopæus* is of a slight form, and the abdominal peduncle is very long. These insects make mud-nests, which are composed of a number of small pellets of moist mud laid side by side or built up so as to form an earthen nest, in which living insects are deposited as food for their larvæ. These mud-cells are provisioned with spiders, caterpillars, and other insects, and the wasps making them are known as mud-wasps, or, more commonly, "dirt-daubers." These clay or mud cells are built against the walls of buildings, commonly under the eaves of the roof in barns or outhouses, or under rails, fences, or any place where they will be partially protected from the inclemency of the weather. *Pelopæus flavipes* provisions its nest with spiders, and the pupæ of a *Sarcophaga*, or two-winged fly, were also found in its cell. *Pelopæus ceruleus*, a dark blue species with clouded wings, is very common in some localities, literally dotting the walls and roofs of some old barns with the large clay nests (Fig. 67).

The perfect insect of *P. cementarius* (Fig. 68), a variety of *P. architectus*, is also figured, to show the general form of these insects.

In the genus *Sphex* the abdominal peduncle and insect are stouter in form than *Pelopæus*. The insect of *Sphex ichneumoneus* digs holes four to six inches in depth in gravelly walks, in which one was seen to deposit a kind of grasshopper (*Orchelimum*) as food for its young larvæ; it then threw in a little earth and flew away. *Sphex flavipes* (Fig. 69) is here figured as occurring in Maryland.

A species of *Sphex* in the island of Bourbon provisions its nest with *Blatta americana* (a cockroach), and *Sphex canieri* of Europe is said to construct a nest of cottony substance, filling a tunnel formed by a curved leaf.

In *Ammophila* the abdominal peduncle (or foot-stalk of the body) is very long and slender. The form of these insects is also slender and lengthened; the wings are somewhat small in proportion. They inhabit sandy places. Mr. Westwood states that the *Ammophila sabulosa* of Europe stores its nest with large green caterpillars, spiders, &c., after forming a burrow in sandy soil, using its jaws in burrowing; and when the jaws are loaded with earth or sand the insect ascends backward to the mouth of its burrow, turns quickly round, flies to about a foot's distance, and throws the sand in a complete shower to about six inches' distance; it then again alights at the mouth of its burrow and repeats the operation of digging out its nest. *Ammophila gryphus* (Fig. 70), a large species, of a black color, with orange band on the abdomen, occurring in the District of Columbia, is here figured. *Chlorion cyaneum* is also classed by Dr. Packard among the *Sphegidæ*, and is of a blue color. The specimen figured was received from the Southern States, and probably in habits resembles the rest of the *Sphegidæ*. Insects of the genus *Pepsis* are generally of large size and indigo blue in color. *Pepsis elegans* (Fig. 71) occurs in the Southern States, and is remarkable for its thickened clay-red antennæ, the body and head and legs being of a dark metallic color, making a vivid contrast. The wings are also dark-colored, with two clay-colored spots on each upper wing and a smaller spot on each of the under. *Pepsis formosa*, of Texas and California, is said to be black, with bluish or greenish reflections, and is remarkable for its bright, fiery red wing.

The family of the *Scoliadæ* is distinguished by its broad front and its small indented, often lunate, eyes; the collar laterally extends to the base of its wings; the legs are short and robust; the antennæ are short and thick, or less serrated and convoluted in the females; the abdomen is elongate ovate and attached by a short pedicel. Both sexes are winged and the body is often very hirsute, and, from the structure of the legs, the females probably burrow in sand. *Scolia bicincta* in Europe is said to burrow in sand-banks to the depth of sixteen inches, and the nest is probably stored with locusts or grasshoppers. *Scolia flavifrons* of Europe is said to live in the body of a large beetle. *Oryctes nasicornis* and another species in Madagascar is also said to live in another. *Oryctes Scolia dubia* (Fig. 72) is here figured as being taken in Maryland; the head and front part of the abdomen is black and the hinder part reddish-brown, with a spot of light yellow on each side; the wings are each clouded with a lilac or blue tinge. In Europe these insects are abundant in the hottest situations and are particularly fond of strong-scented flowers, such as Rue, &c. *Typhia inornata* (Fig. 73) is common in Maryland in sandy places; it is a medium-sized, plain-looking, black, wasp-shaped insect, and was taken on flowers in Maryland. An insect of the genus in Europe made a perpendicular burrow in sandy places for the reception of her egg, but the food stored up for the larvæ was not observed.

In *Myzene* the form of the sexes is very dissimilar, the eyes of the male being large and lunate, while in the female small, remote, and entire. These insects frequent hot, sandy places. *Myzene sexcincta* (Fig. 74, male and female), a somewhat common species here, is figured. *Elis costalis*, a foreign species, lives in certain beetles and undergoes its metamorphoses in the formicary of *Acodoma* (a species of ant), in Mexico. *Elis quadrimaculatus* (Fig. 75), or a closely allied species, is here figured.

Insects of the family *Mutillidæ* are generally found in hot, sandy situations, running with great swiftness over the bare places, and when alarmed they hide themselves among stones and grass or weeds. In habits they are said to resemble the sand-wasps already described. The larvæ of *Mutilla europæa* are said to live parasitically in the nests of humble-bees. The insect, however, has been dug out of sand banks, but has never been observed in the act of burrowing.

Westwood states that a North American species, *Mutilla coccinea*, is very active, taking flies by surprise, probably for the sake of storing its nest. The sting is exceedingly powerful. The males of *Mutilla* are furnished with wings, but the females are apterous, or wingless, and remain upon the ground or fallen logs, while the males, being winged, are frequently taken on flowers. The wingless females of *M. unicolor* resemble ants in form, and are found as far north as Maine. The female of *Mutilla occidentalis* (Fig. 76) is of a beautiful scarlet color, and has a velvety appearance. The first part of the hind body, nearest the thorax, is black, and the abdomen is also broadly marked with a black or dark band. The male, also figured with the above, is winged. Professor Verrill found this species constructing deep holes in a hard-beaten path, and storing it with small insects. One of the family of *Mutillidæ*, in Texas, is known by the local name of cow-killer. Some of these insects exceedingly resemble ants, but may readily be distinguished by the antennæ, which are *not* geniculate-elbowed or formed like a flail. The family of the *Formicidæ* comprises the ants, the majority of which live in societies under ground. These communities are generally composed of three classes—namely, the males and females, both of which are furnished with wings, and the neuters, which perform all the work and are perfectly wingless. Their antennæ are long, slender, and elbowed or geniculate. In this neighborhood ants do not appear to store up a supply of grain for winter use, as is generally supposed, but live on small seeds, dead or disabled insects, &c., as it were from hand to mouth; and the grains of wheat said to be so plentifully found in the autumn in their nests are nothing but the cocoon or cases enveloping their larvæ or pupæ, and often erroneously called ants' eggs. Bird-fanciers in Germany collect these so-called eggs in great numbers as food for soft-billed singing birds. The ants' hills or nests are first knocked in pieces and scattered abroad, and pieces of bark and small branches of trees laid here and there upon the ground, when the ants diligently carry these so-called eggs into little heaps to preserve them from the sun and weather, where they are readily collected by the bird-fanciers, and sometimes dried in the oven for winter use. *Formica* of Linnæus is described as sting-wanting, and abdominal peduncle consisting of a single elevated scale, while *Myrmica* has the abdomen armed with a sting and has the abdominal peduncle two-jointed.

So many stories will be found in all our popular works on natural history about the slave-making propensities of various species of ants, together with their forays and battles, that we will not enlarge upon the subject in this report, but merely mention a few species that are remarkable for their destructive habits, peculiarities of structure, form, or mode of life. One of the largest species in this neighborhood, *Formica caryæ*, (Fig. 77, male and female), is of a black color, and inhabits hickory trees, boring passages in the wood, the sides of which are very much discolored and softened, probably by the formic acid emitted by these insects. The high-hole or yellow-winged woodpecker, in spring, if shot, and the stomach examined, will be found completely filled with the bodies of ants in all stages of digestion, gathered from the hollow forest-trees in the woods of Maryland, and smell most disagreeably of formic acid. *Formica pubescens* is mentioned in Canada as eating the wood of cedar trees and constructing partitions as thin as paper. *Formica pennsylvanica* is mentioned by Packard as the largest species, and is found on oaks and decayed trees, and *F. novæboracensis* is mentioned by Fitch as found with the apple-aphis or plant-louse on apple trees, and keeping in the society of the aphides for the sake of the sweet, sticky substance emitted by the plant-louse, and which is eagerly devoured by the ants. On young fruit trees ants have been frequently accused of injuring the shoots and foliage‘ when they really only frequent such places for the so-called honey-dew above mentioned. On a Georgia cotton-plantation a large number of small ants were observed to kill and devour the grass army-worms, and let a small caterpillar or insect be in any way injured, it was sure to be attacked and eventually killed and dragged away by the ants.

Myrmica differs from *Formica*, as before stated, in having the abdominal peduncle not formed of only one scale but as having two joints, and being possessed of a sting.

Myrmica cerasi is a small ant, called by Fitch the cherry ant, from its frequenting the cherry trees, where it feeds on the sweet honey-like substance that exudes from the cherry plant-lice. The color of the neuters is dark brown, and the body is highly transparent, resembling rosin. The abdomen is black, highly polished, egg-shaped, and acutely pointed at its apex. The legs are likewise black.

Myrmica molesta is a small yellow ant, 0.06 in length, found throwing up hillocks of earth in gardens. It is reported sometimes to injure maize by gnawing the blades for the sake of the sweet juice. A similar insect is said to have been naturalized in England, and a very small yellow ant is very troublesome in Georgetown and Washington, swarming over the food, especially anything very sweet in pantries. A lady recommended for the destruction of these pests a very troublesome yet effectual remedy, viz: a large sponge must first be dipped in water and then gently squeezed and sprinkled with powdered sugar; this sponge must then be laid in the places frequented by the ants, and every quarter or half hour examined, and if covered with ants it should be plunged in boiling water and then again baited with the sugar. The lady said this plan was eminently successful, as in a few days her house was completely rid of these little pests. Where there are no eatables around in gardens, &c., the nests may be blown up by gunpowder, squibs, &c. If Paris green, mixed with cooked potatoes or their favorite food, be applied, the insects would certainly be poisoned, but great care should be taken when applying the poison. Drowning them out is of little use, as after an immersion of several hours the insects are apparently uninjured. A foreign species, *Myrmica* (*Alta*) *Carbalo*, is mentioned as storing the grain of a particular rice-like grass, and is said, also, to maintain a clear crop of this plant round its nest, suffering no weed to appear among it, and harvesting the crop at the proper time. The same is, however, said of *Myrmica molefaciens*, or the agricultural ant of Texas, which may be the same or a very similar insect. This ant is said by Mr. Lincecum to live in communities and to build paved cities, construct roads, to sustain a military force, and to clear away the grass and herbage and other litter to a distance of three or four feet around the entrance to their city, and to construct a pavement consisting of a pretty hard crust about half an inch thick, formed of coarse sand and grit; and no green herb is allowed to grow on this pavement excepting a grain-bearing grass, *Arista stricta*. This grain when ripe is harvested, the chaff removed, and the clean grain is carefully stored away in the dry cells. Lincecum even avers that the ants sow the grain. These two last accounts are so much alike that it would lead to the belief that they refer to the same insect under two different names.

The honey ant of Mexico, *Myrmecocistus mexicanus*, deserves a short notice here, as it is reported to have been found in parts of Texas also. This ant has two kinds of workers, of very distinct forms: one of the usual shape performing the active duties of the ant-nest; the other and larger worker is inactive and does not quit the nest, its sole purpose apparently being to elaborate a kind of honey which they are said to discharge into receptacles, which constitutes the food of the entire population of the community. In the honey-secreting workers the abdomen is distended into a large globose bladder-like form; from this honey an agreeable drink is made by the Mexicans. The specimens from which these drawings were made were presented to the department by Professor Uhla, and appeared like small bladders filled with a yellowish-brown liquid, with only the head, throat, and legs of a small ant attached to the swollen bladder. The honey was sweet, with a slight taste of formic acid, and was quite clear when the insects were crushed and the bodies of the insects had been strained out of the honey. *Pheidole providens* of Westwood, according to Colonel Sykes, is a foreign ant, which collects so large a store of seeds as to last from January to October. *Œcodoma*, another ant, is said to be a great pest to agriculturists, as the insects strip trees of their leaves in order to convey them to their nests. *Œcodomo texiana* constructs tunnels and subterranean roads, and cuts the leaves from various fruit and forest trees.

Pseudomyrmica flavidula, a South American ant, lives in the spine which arms the stems of certain species of *Mimosa*, specimens of which were kindly donated to our museum by the Smithsonian Institution.

Insects of the family *Eumenedæ* have the basal segment of the abdomen narrowed and pear-shaped, and comprise solitary species of wasp-like insects, composed of males and females only. *Eumenes fraterna*, or the Potter wasp (Fig. 78, three figures), is very common in this neighborhood, and makes its cell of moist clay or mud. These cells or nests are about the size of a small cherry and are composed of pellets of mud, and are generally cemented to the stems or small branches of trees and shrubs, and sometimes even on a leaf.

These round flanked-shaped nests are filled with small caterpillars of the different *Lepidoptera;* frequently, in the Eastern States, of the living caterpillars of the canker-worm (*Anisopteryx vermata*). The caterpillars, after being first paralyzed by the sting of the wasp, are carefully stored up in the nest as fresh food for the larvæ of the wasp. Mr. Walsh states that he has seen as many as five of these nests all placed together on the lower surface of a leaf; we, however, have mostly found them solitary, or, at the most, two nests placed near each other.

In June the perfect potter wasp emerges from its cell and lays the foundation of other similar cells. We hatched a *Toxophora* (a two-winged parasitical fly) from the nest of *Eumenes fraterna*, where no doubt it had, as larva, destroyed its benefactor. A species of *Chrysis* (*Hymenoptera*) is also supposed to be parasitic on this insect. In *Odynerus* the abdomen is broad and conic; the basal segment short and somewhat bell-shaped. *Odynerus* (Fig. 79) *birenimaculatus* from Maryland, is here figured. *Odynerus muraria* of Europe, forms a burrow in the sand to the depth of several inches, in which it constructs its cell, besides which it builds with the grains of sand brought up while burrowing, a tubular entrance to its burrow, often more than an inch long and more or less curved, the grains of sand of which it is formed being agglutinated together. This nest it stores with caterpillars and deposits an egg in each cell, and when the store of food is secured the insect closes the mouth of its burrow, employing the grains of sand of which the funnel is composed for that purpose. *Odynerus albophaleratus* of Saussure, builds separate cells half an inch in depth and a quarter of an inch in width, formed of small pellets of mud, giving them a corrugated appearance, and builds in deserted galls of a gall-wasp or *Cynips*. It has been found also in the deserted nest of a

Clisiocampa or tent caterpillar, and the pupa has also been taken in the deserted cells in a syringa-stem. The cocoon was made of silk without any mud cells. Various European species of *Odynerus* store their nests with different insects; one species uses flies as well as caterpillars of *Torlvix*, a small moth, and other *Lepidoptera*; another species uses the larvæ of *Chrysomela* (a beetle), and one species is mentioned as being destroyed by the larva of *Tachina*, a two-winged fly.

The *Vespiariæ* of Lerveille, or *Vespidæ*, according to Westwood, are restricted to those species which live in temporary societies, consisting of males, females, and workers, or neuters, including the common wasp and hornets. These societies are annual, only being dissolved at the approach of winter. Previous to the setting in of cold weather the females, which have but recently been developed, are impregnated by the males, which soon afterward die. The females then disperse, seek winter quarters in sheltered situations, and those which survive the rigors of winter, in spring commence the building of a new nest in which they deposit eggs and tend their young themselves—those at first consisting entirely of neuters, which assist their parents in the duties of the nest. These nests are either built under ground in holes, in banks, or are attached to branches of trees, or the woodwork of outhouses; some of them are composed of a paper-like substance formed of finely gnawed wood, or bark of trees reduced to a paste by the action of the jaws. These insects are voracious and prey on other insects, meat, fruit, honey, &c., which being properly prepared in the stomach of "the winged insects, is disgorged and serves as food for their young." The males are drones and perform no labor. The stings of wasps are very painful, but are very soon alleviated by the application of spirits of hartshorn or ammonia. The larvæ are fleshy grubs destitute of feet, and are each inclosed in separate cells and in a reversed position, having their heads downward in those species having hanging nests. The insects of *Vespa maculata*, or the bald-faced hornet, catch flies, &c., to feed their young, and construct nests of a material like paper made from wood fibers. The wasps with their powerful jaws gnaw off small filaments of wood from old fence-rails, posts, &c., which they chew into a pulp and spread out into sheets of a strong gray water-proof paper, which forms the material of their nests, and which are generally suspended from the branches of trees. They are frequently larger than a man's head, and of a globular form.

These nests are covered with an outer envelope of many irregular layers of paper. The inside consists of layers of hexagonal cells suspended from the top, and from those above, by numerous little pillars of the same *papier-maché*, leaving a passage-way between the different tiers of cells. These combs are placed in a horizontal position and contain each of them but a single egg, which, when hatched, becomes a larva suspended with its head and mouth downward in the mouth of the cell, and from which it is fed by the other wasps.

The communities consist of males, females, and neuters. Mr. Walsh also states, however, that some of the workers can and do generate without any intercourse whatever with the male. The nest figured (Fig. 80) is reduced in size. *Vespa germania* (Fig. 81) is figured from a specimen taken in Maryland. This species and *Vespa vulgaris* have indiscriminately been called "yellow-jackets." Mr. D. A. A. Nichols, of Westfield, N. Y., writes that the yellow-jackets in his neighborhood all build nests in trees or bushes and not in the ground as generally supposed. One nest was particularly mentioned as built near the roof of a grainary, and was 16 inches in diameter and 20 inches in length. Mr, Walsh, however, states that all the species with which he is acquainted build in the ground.

Wasps are subject to the attack of several parasites. *Phipiphorus paradoxus* and the Lebia (a beetle), *Volucella*, a large two-winged fly, infest wasps' nests, and two species of *Ichneumon* flies, one of which is anomalous, infest the larvæ. Dr. Packard, however, states that no parasites have as yet been detected in this country.

Wasps and hornets frequently feed upon and injure ripe fruits. They are said also to destroy honey-bees, but are also beneficial by destroying flies and other insects. A species of wasp in the West Indies is said to be infested by a parasite plant or fungus which rises from the segments of the abdomen and other parts of the body, presenting the singular appearance of a living wasp carrying a living plant.

A somewhat similar fungoid growth from the head of a harvest-fly, or *Cicada*, has been presented to our museum, and in Australia a fungoid growth grows from the caterpillar of a moth. *Vespa crabro* (Fig. 82) builds its nest in decaying hollow trees, under the eaves of barns, and, according to Mr. Angus, of West Farms, has been introduced about New York Insects of the genus *Polistes* are much slenderer in form than the true wasps, and distinguished by having the first segment of the abdomen separated by a slight constriction from the second segment. The food of the perfect insect is partly vegetable and partly animal, consisting of honey, pollen, and various insects. The insects are mentioned as being great friends to the growers of tobacco, as destroying the caterpillars of the tobacco-worm (*Macrosila carolina*) when they are very small, in July and August, by carrying them off as food for their young, and are themselves destroyed by an *Asilus*, or large two-winged fly. Insects of the genus *Polistes*, according to Westwood, do not inclose their nests in a general inclosure like *Vespa*, but leave their cells exposed, attaching them to stems of plants, walls, &c., sidewise.

Polistes gallica (Fig. 83), of Europe, is said by St. Fargeau to build nests having cells filled with honey; and the nest figured has been figured from Westwood, as giving some idea of their style of building.

A foreign species, *Polistes lecheguana* (Fig. 84), is said to make an abundant supply of honey. A rather common species, *Polistes flavesps* (Fig. 85), is figured as from Maryland, together with a small unfinished nest. Say mentions *Polistes millifica*, which lives in a paper nest near Jalapa, and makes a kind of honey having a very pleasant taste. *Polistes rubrigenosa* (Fig. 86), of the United States, is mentioned by Riley as carrying off the larvæ of the Colorado potato-beetle, *Doryphora* (*Chrysomela*) *decemlineata*, to its nest as food for its young. The rest of this family, according to Westwood, consists of the bees, the larvæ of which feed exclusively on pollen and honey, and the insects of which consist of males, females, and drones or neuters; some of them live in societies, as the honey-bee; others, however, are solitary in habits, &c., and consist only of males and females without any neuters, the female building the nest, which is generally composed of a series of cylindrical cells for the reception of the eggs and pollen-paste to feed their young when hatched; and a third class, which are solitary and do not build nests at all, but deposit their eggs, cuckoo-like, in the already provisioned cells of other bees, when, by eating up the food laid up, they starve out and kill the rightful owners.

The *Andrenidæ*, form the first family of Westwood (subfam. *Obtusilingues*), in which *Colletes* is mentioned as having the females resembling the workers of the honey-bee. These insects form large colonies and burrow deep in the earth, at the end of which burrows are several cartridge-like cells, and each covered with a cap like the parchment on a drum-head. Westwood states that these insects nest in the earth and the softer parts of walls. Each nest is cylindrical, consisting of from two to four cells placed end to end, the bottom of one fitting into the mouth of that beneath it, and in each cell are deposited an egg and a quantity of pollen to serve as food for the larva when hatched. They are subject to the attacks of parasites in Europe, among which is *Millogramma*, a two-winged fly, and a cuckoo, or guest-fly, *Epeolus*. The second subfamily of Westwood (*Acutilingues*,) contains the genus *Sphecodes*, of which Dr. Packard states that the body is smooth and wasp-like, with the abdomen of a light-red color. Mr. F. Smith says that this genus builds cells, although it has been stated by some authorities in Europe to be parasitical on *Halictus* and *Andœna*. *Halictus* contains some very small species in England, sometimes of metallic colors. *Halictus parallelus*, of Say, excavates small deep holes, from six inches to a foot in depth, the cells of which are glazed within. The females are supposed to hibernate, and each larva is in a cell by itself, placed upon a lump of pollen on which it feeds. Westwood says that *Halictus terebrator* of Europe makes burrows in beaten tracts and deposits small balls of pollen slightly moistened with honey in cells with their eggs, and the burrows are often observed in great numbers placed close together. *Halictus ligatus* (Fig. 87) is figured as found in Maryland.

Andrena very much resembles the common hive-bees of Europe. They make their cells in light, sandy soil, five inches to a foot under ground, and deposit an egg in a mass of pollen, and when the eggs have been properly placed the female stops the mouth of her burrow. The habits of *Andrena vicina* have been described by Mr. Smith. The larvæ were taken full-grown in June, the pupæ were found the first of August, and the mature bee appeared the last of the same month. The female of *Andrena nigroœnea* (Fig. 88), of Europe, is figured from Westwood. *Andrena* is subject to parasitic insects which destroy it. *Stylops*, an insect now classed with the beetle, and *Braula cœca*, figured among the *Dipleia*, or two-winged flea, are mentioned as destroying this insect.

Professor Packard here mentions *Angochlora* as a beautiful, shining, metallic-green species, very commonly met with, and which forms a burrow, the last of June, about four inches in depth. *A. purus*, a small green species, is found in Salem, Mass.

Prosapis is mentioned by Mr. Smith, who states that this genus is not parasitical, as formerly supposed, as he has repeatedly bred them from cells laid in regular order in the hollow of bramble-stems.

Mr. Saunders, of Canada, also says they construct their cells in bramble-sticks, which they bore in the same manner as *Colletes*, with a thin, transparent membrane, calculated for holding semi-liquid honey, which they store up for their young. These insects are much attacked by a *Stylops*, before mentioned.

In the genus *Sphecodes*, Dr. Packard states that the body is smooth and wasp-like, with the abdomen light-red. Mr. F. Smith says that this genus builds cells, although it has been stated to be parasitical on *Halictus* and *Andrena*.

Family 2, *Apidæ*, or bees, of Westwood (subfam. 1, *Andrenoides*), contains the genus *Panurgus*, the insects of which are stated to "revel in honey-pollen of a large anthemis, and to be attached to semi-flocculent flowers"; they are furnished with a pollen-plate on each side of the metathorax, and another on the posterior femora, and the hind legs have also pollen-brushes.

Subfamily 2, *Denudatæ*, of Westwood, contains the naked, or smooth bees, or those not clothed with long hairs. The genus *Nomada* contains gayly colored bees resembling wasps. They are destitute of hairs, and have no instrument for conveying pollen. In Europe they frequent dry, sunny banks, and are generally known as guest, or cuckoo bees, as they are said to be parasitical in the nests of other bees, feeding upon the pollen laid up for the young larvæ of the rightful proprietors. They are reported to infest the nests of *Andrena*, *Panurgus*, and *Eucrga*, in Europe; the females do not sting severely, and give out a sweet scent.

Nomada imbuicata and *pulchella* have been found in the nest of *Andrena vicina*, and *Nomada pulchella* in the cells of *Halictus paralillus*. In both these cases it appears that the larvæ of *Nomada* must feed on the pollen-mass destined for the other bees, but Dr. Packard adds, however, that the masses of pollen seem to be enough for both genera to feed upon, as the young of both host and parasite were found living harmoniously together, and the hosts and their parasites were both discovered at the same time. *Nomada bisignata* (Fig. 89) as figured, was taken in Maryland.

Subfamily 3, *Longilabra*, of Westwood, is, as its name imports, distinguished by the oblong form of the upper lip. The genus *Cœliodes* is also a cuckoo, or guest bee, and lays its eggs in the nests or cells of other bees. Dr. Packard says the body is stout and the bee mimics its host. *Megachile*. The insects are found in flowers. *Melecta*, of Latraille, is said to be short and hirsute, and in Europe, according to Westwood, is parasitic in nests of *Anthidium*. *Megachile*, *Osmia*, *Anthophora*, and *Epeolus* are parasitic in *Colletes*. According to Dr. Packard, in the genus *Anthidium* the males are much smaller than the females, and the abdomen is broad and armed with lateral and terminal spines; the insects frequent woolly-leaved flowers, stripping off the down to form their nests, which they place in holes of trees, &c. They hibernate in the larva state, and the bees make their appearance in summer. *Anthidium manicatum* (Fig. 90), a European species, is figured here from Westwood.

Insects of the genus *Osmia* are commonly known by the name of mason-bees. Their habits are various. Some of them make cells in holes or in rotten palings and posts, others construct nests of minute grains of sand cemented together with a glutinous secretion, in angles of walls, or crevices between bricks. In Europe *Osmia gallarum* forms nests in abandoned oak-galls, around which it glues the leaves. *Osmia helicola* forms nests in deserted snail-shells, and others, *Osmia lignaria* of Say, were found in a perfect state in earthen cells beneath stones. Its cell was half an inch long, cylindrical, and contracted slightly into a sort of net just before the opening of the exit of the bee. The insect of *O. lignivora* (Fig. 91) is 0.50 in length, of a deep, blackish-blue color, with greenish reflections, and was tunneling in wood of elm, the tunnels being three inches in length by three-tenths in width, and which contained five somewhat jug-shaped cells.

The genus *Megachile* comprises the leaf-cutting bees, and are distinguished by their oval abdomen, and very short two-jointed maxillary palpi. The jaws and labrum are very large. These insects form nests in trunks of decayed trees, in holes of old palings and posts, &c., which are lined with pieces of leaves of a circular form, cut from plants and shrubs by their jaws, and curiously fitted together so as to form linings to their cells. The bottom of these cells being concave they fit into the mouth of the cells beneath; several of them are found in one burrow, fitting into each other like a nest of thimbles. One European bee uses pieces of the leaves of a scarlet poppy, others use leaves of roses or other plants. Some nests were found in old galls of *Callaspidia* (*Cynnis*) *confuenta* (Fig. 92) in Maryland. *Megachile centunculus* is a very common species, and forms its nests with circular leaves cut from rose-bushes. *Megachile arcuata* (Fig. 93, two figures), is a somewhat common species, and is sometimes found in stems of elder. The nest of *Megachile brevis*, of Say, is also made of rose-leaves, and is scarcely different from *M. centunculus*. *Megachile* is destroyed by minute Ichneumon flies, *Arthophorcbia megachilis*.

The genus *Ceratina* in habits and structural characters closely resembles *Xylocopa* mentioned below. Their nests are formed in the pith of brambles and briars out of which they scoop the pith, and deposit in them at regular distances masses of a coarse sort of honey on which the larva feeds. Other authors, however, have asserted (erroneously) that they are parasites in nests of *Osmia*, &c. *Ceratina duplex* (Fig. 94) is a small, bright-green, smooth-bodied species, which burrows out the stems of alder, blackberry, syringa, aster, &c., or other pithy shrubs and plants, excavating them frequently to the depth of six or seven inches. It takes about two months for the insect to complete its metamorphosis to the perfect bee, which lives through the winter.

The fourth subfamily of Westwood, *Scopulipedes*, derives its name from the thick lining of hairs upon the hind legs of the female, and which constitute the pollen-brushes; they have no pollen-plates, and the abdomen is destitute of pollen-brushes. The sexes are often very different both in structure and color. The males in some having very long antennæ, in others the posterior tibiæ are thickened, while in a few the tarsi of the intermediate legs are furnished with curious brushes of hair. Their nests are formed in the crevices of old walls and in the ground on sunny banks; their cells are made of earth, and very smooth on the inside, and when finished the mouth of the nest is filled with earth. Males of the genus *Eucera* are distinguished by the great length of their antennæ (hence their name), which are nearly the length of the body. The cells of the European species are formed under ground at a depth of two or three inches, and their internal structure is very smooth.

Eucera maculata is a common species here, and they are said to be gregarious in habits, their nests being placed near each other. The genus *Anthopliora* resembles *Bombus* or the bumble-bee in its plump and hairy body. They are also gregarious, their numerous cells, although independent of each other, being crowded together in grassy banks. The insects themselves are troubled with parasites; a species of *Melecta* lays its eggs in their cells, and their larvæ are infested with flies of a *Chalicis*, *Antherophorabia*, and *Monodontomerus*, and a peculiar kind of mite, *Heteropus ventuicous*, according to Dr. Packard. The European species, *A. vetusa*, makes its nest in hard, dry banks, and in crevices of walls, burrowing through the mortar, and causing much damage by loosening the bricks.

The genus *Xylocopa*, or the tree-carpenter bees, contains some very large species. *Xylocopa* of Europe, by means of its jaws, burrows in the wood of posts, palings, &c., and forms passages twelve or fifteen inches in length, of rather more than half an inch in diameter; the top and bottom of the tunnel are curved, having a passage at each end. When the burrow is complete the bee deposits an egg at the bottom, with a proper supply of pollen-paste, and the whole is then covered with a layer of agglutinated sawdust, formed during the construction of the burrow. The layer thus formed serves not only as the roof of one cell, but as the floor of another, which is placed immediately above it. They thus proceed until about a dozen cells are formed. When the larvæ are full grown they assume the pupa state, head downwards, so as to allow the lowermost and eldest to make its way out of the bottom of the burrow, as soon as it becomes winged, and which in consequence takes place earlier than in those which occupy the upper cells.

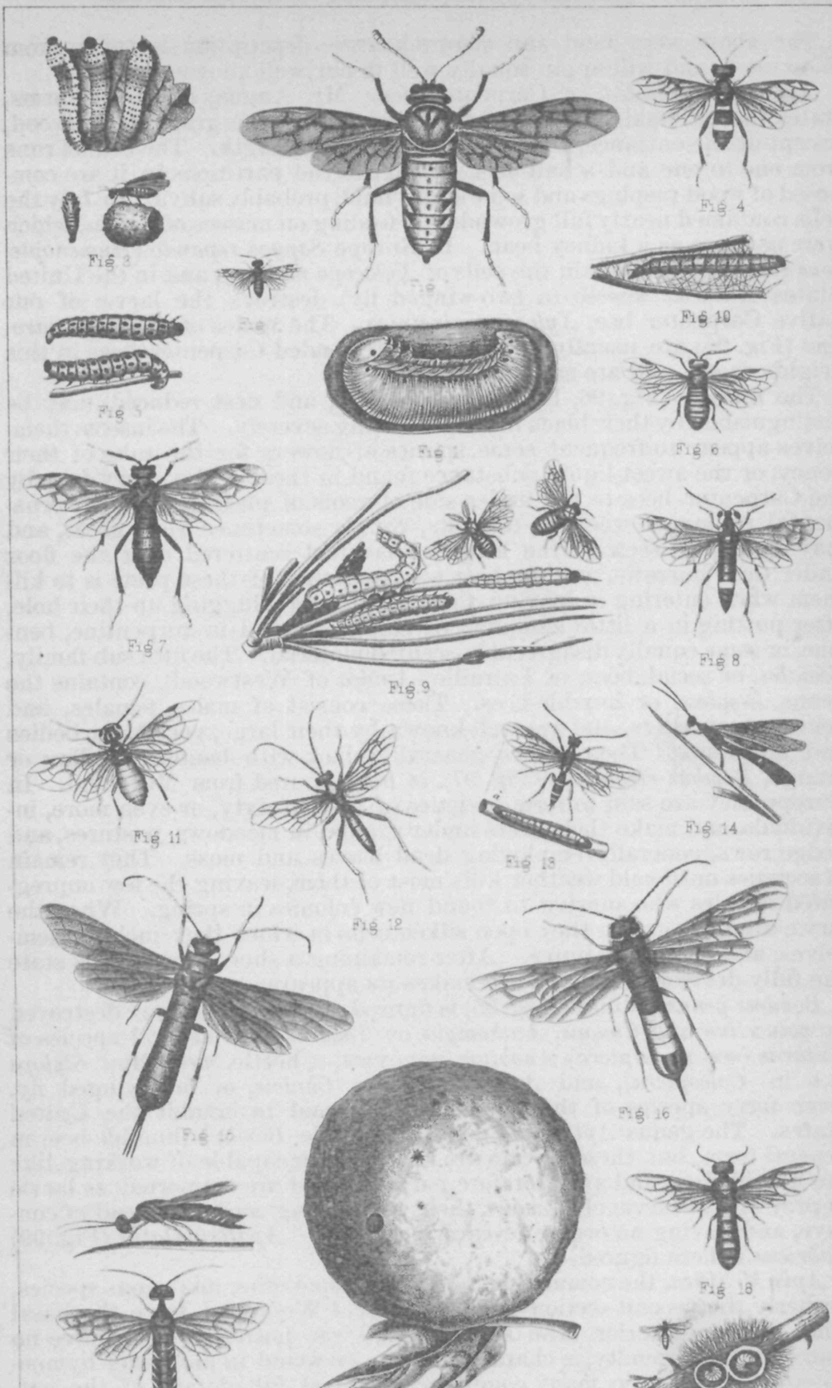
The above very lucid and comprehensive description is taken from Westwood, and will apply equally well to our well-known species.

Xylocopa virginica, or Carpenter bee. Mr. Angus, of West Farms, states that in making its burrow the bee follows the grain of the wood, except at the entrance, which is about her own length. The tunnel runs from one to one and a half feet in length; the partitions in it are composed of wood-raspings and some sticky fluid, probably saliva. In July the cells contained nearly full-grown larvæ feeding on masses of pollen, which were as large as a kidney bean. In Europe *Sapyga repando* (*Hymenopterous insect*) is parasitic in the cells of *Xylocopa violacea*, and in the United States *Anthrax simoso* (a two-winged fly) destroys the larvæ of our native Carpenter bee, *Xylocopa virginica.* The males of *Xylocopa carolina* (Fig. 95) are usually known as white-headed Carpenter bees in this neighborhood, and are said not to sting.

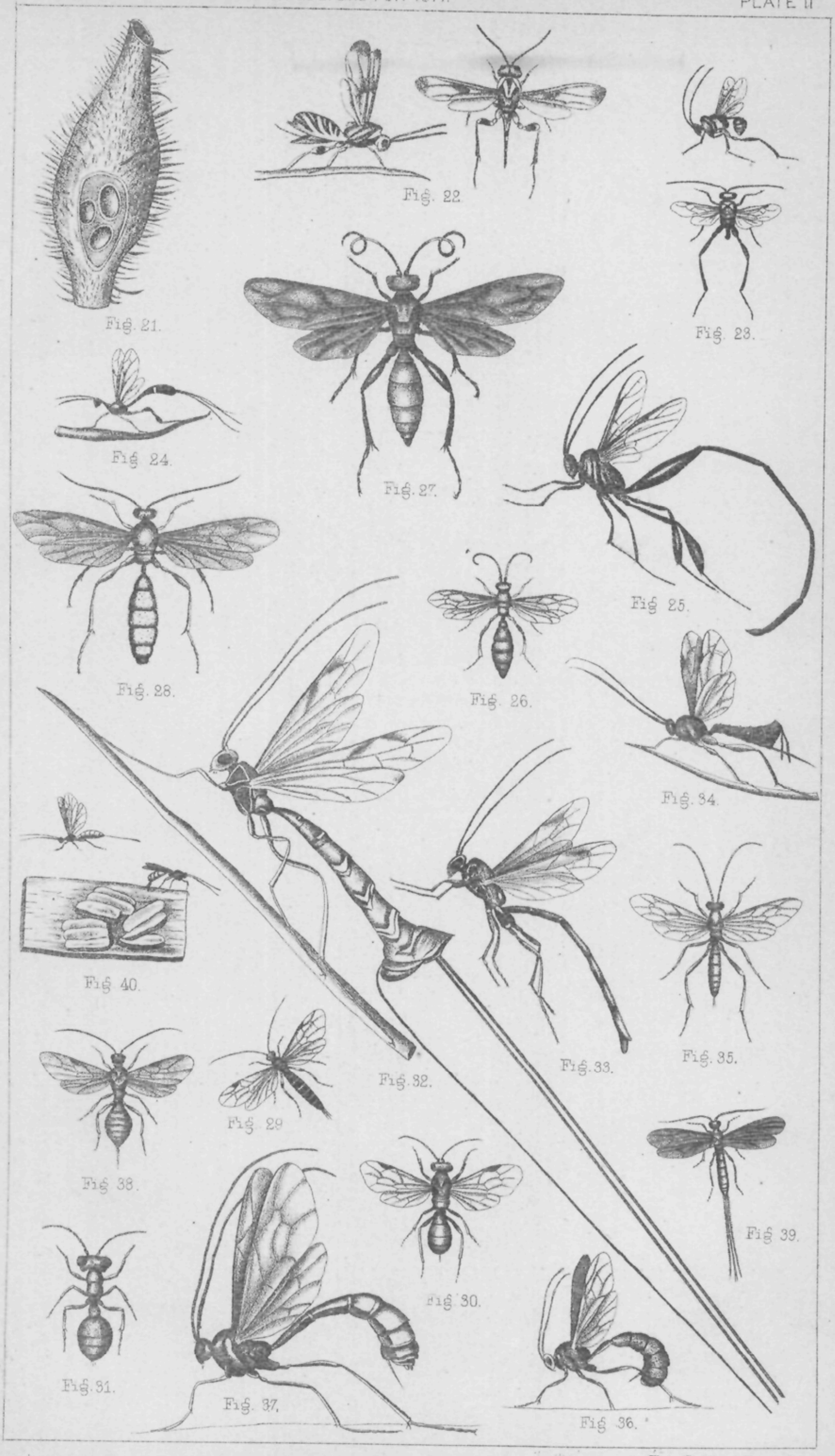
The females (Fig. 96, insect, natural size, and nest reduced) may be distinguished by their black heads, and sting severely. The insects themselves appear to frequent some species of flowers for the sake of their honey, or the sweet liquid substance found in them. The injury done by the Carpenter bees to the under side of roofs of piazzas, or under ornamental railing of wood or to posts, &c., is sometimes very great, and may readily be seen by the heaps of sawdust scattered over the floor under their burrows, and the best way to get rid of these pests is to kill them when entering or leaving their burrow, or plugging up their hole, after putting in a little camphor, or cotton steeped in turpentine, benzine, or some equally disagreeably-scented material. The fifth sub-family, *Sociales*, or social bees, of Latraille (*Apidea* of Westwood), contains the genus *Bombus*, or humble-bees. These consist of males, females, and neuters or workers, and are well-known by their large, very hairy bodies and great size. Their colors, generally black with bands of yellow or orange, *Bombus virginicus* (Fig. 97), is here figured from Maryland. In Europe they are said to form societies of fifty to sixty, or even more, individuals, and make their nests under ground in meadows, pastures, and hedge rows, generally employing dead leaves and moss. They remain in societies until cold weather kills most of them, leaving the few impregnated females who survive to found new colonies in spring. When the larvæ are fully grown they open silken cells in which they inclose themselves, and change to pupæ. After remaining a short time in this state the fully-developed humble-bee makes its appearance.

Bombus pennsylvanicus (Fig. 98) is figured. These insects are destroyed by *volucellus* and *Conops*, *Authomyia* or *Tachina*, and several species of *Anthras* (see in *Diptera*) *Anobium paniceum*, a beetle, *meloe* and *Slylops* (see in *Coleoptera*), and *Antherophagus* a *Chalcis*, or four-winged fly. Over forty species of the humble-bee are said to inhabit the United States. The genus *Apthus* is said to resemble *Bombus* (humble-bee) in general form, but these insects are said to be incapable of working like the humble bee, and are therefore parasitic, and are supported as larvæ to prey on the larvæ of *Bombus*, their tibiæ being convex instead of concave, and having no organ for carrying pollen. *Apathus elatus* (Fig. 99) *Fabricus* is here figured.

Apis Mellifica, the common hive bee, and some other analogous species, formerly the second section of the Socials of Westwood, have the basal joint of the posterior tarsi striated, and the posterior tibiæ have no spurs at the extremity, a character not to be found in any other hymenopterous group. So many comprehensive and full details of the natural history, habits, structure, and treatment of these insects in a state of domestication may be found in former pages of these agricultural reports of the Department of Agriculture, and in the various treatises on



Thos Sinclair & Son. Lith



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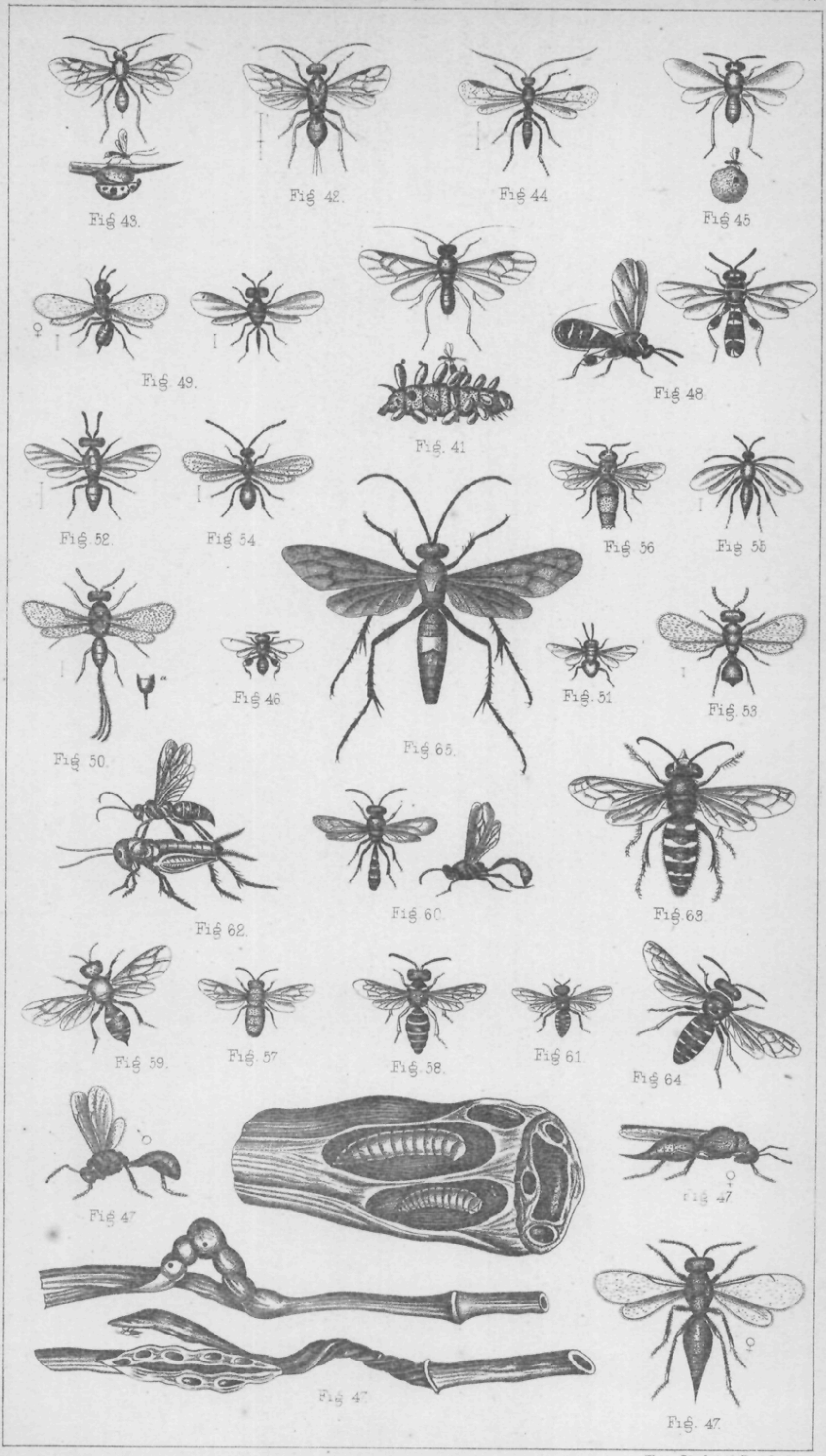

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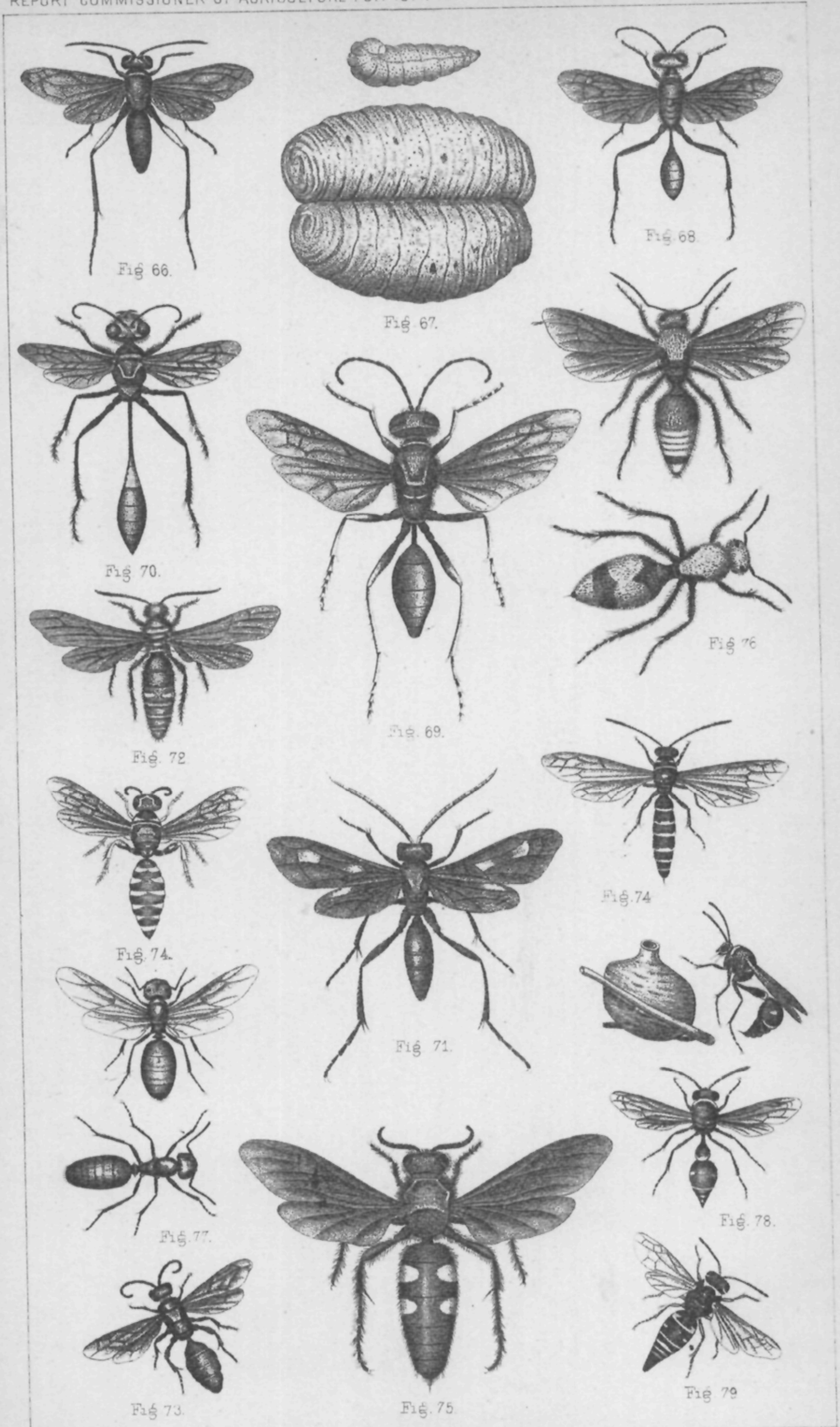

Fig 66. Fig 67. Fig 68. Fig 70. Fig 69. Fig 76. Fig. 72. Fig. 74. Fig. 71. Fig. 74. Fig. 77. Fig. 78. Fig. 73. Fig. 75. Fig 79.

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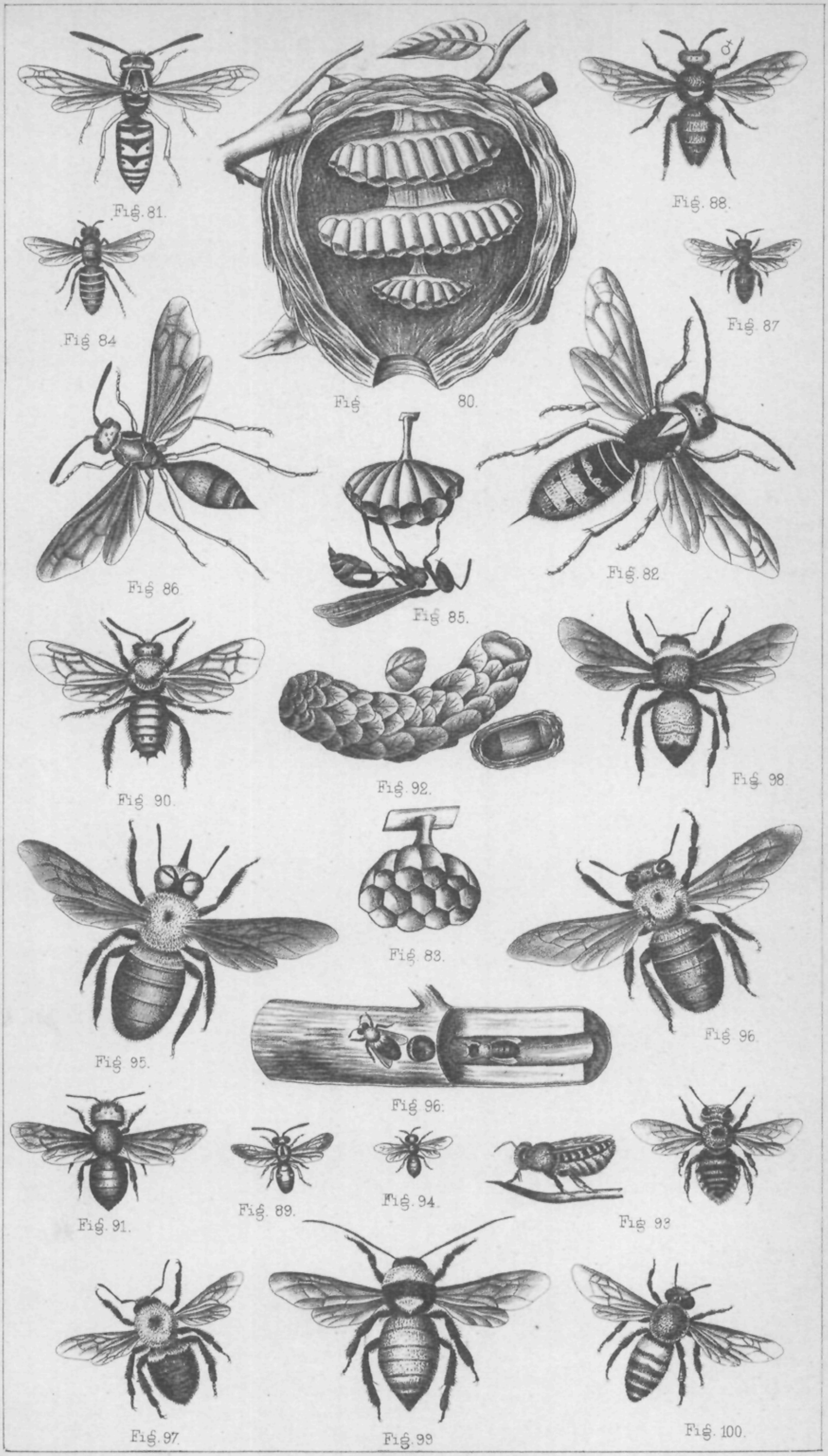

Thos. Sinclair & Son, Lith.

the bee and its culture, that it will be useless, and take up too much space, to recapitulate them here. We will therefore merely add a few notes on the subject, and give a list of the varieties of Honey bees that are domesticated or raised in the various countries, from Westwood.

Apis mellifica is our common honey bee from Europe and imported into the United States. *A. ligustica* is kept in some parts of Italy; *A. fasciata* in Egypt and some parts of Asia Minor; *A. unicolor* in Madagascar; *A. indica* in Bengal; *A. adansonii* in Senegal; and an undescribed species is known in Chili. *Apis lingustica* (Fig. 100), the second bee mentioned in this list, is said to agree with the description of the honey bee in Aristotle.

These bees have been introduced into the United States, and when kept pure and unmixed with our common honey bee are said to be milder in their temper and more diligent in laying up honey. They may be distinguished by their color and by having a broad orange ring or mark on their abdomen.

Not having a specimen we have taken our figure from the naturalist's library. The common honey bee is destroyed by several parasites, among which will be found *Phora incrasiatu*, or bee fly; *Braula caeca*, or bee louse; *Trichodes*, a beetle; *Clerus apiarius*, &c., of Europe, also a beetle; *Melöe* and *Slylops*, both coleopterous insects; and a gordius or hair snake or worm. The bee moth (*Galleria cereana*), however, is one of the greatest troubles to the bee keeper, as their large, yellowish-white, clumpy larvæ or grubs eat through the wax cells in the hive and spin their filthy webs throughout the comb, and thus cause the bees to desert the hive. There are several patent hives which are said to be moth-proof, and which are highly recommended by the patentees and others, but in this case the department can recommend no particular hive, but leave the subject entirely to the apiarians themselves to decide which is the best and most reliable. Some years ago we ourselves cleared a hive of the bee moth by merely laying three or four hollow pieces of elder, split lengthwise down the middle and notched here and there at the sides, making holes into which the worms retreated in the night when fallen from the comb on to the foot-board of the hive on which the bee-traps were placed. These sticks were withdrawn very early every morning and examined, the grubs killed, and the sticks replaced immediately.

On the first few days after applying these traps on the foot-board of the hive, at least 10 to 15 worms were taken daily until at last they dwindled down to only 3 or 4; finally these troublesome pests were destroyed. At the same time, however, the hive was examined, and all the perfect moths found were immediately killed, and the wrens were encouraged to build close to the hives to destroy the insects and fallen worms on the ground. The elder sticks were only used before the introduction of the numerous patented hives and other devices which have of late been used.

A hive of stingless bees was once sent to the departmental gardens from South America, in a hollow tree or log, but, although they lived and worked a little during the heat of summer, all died during the first cold weather. Their comb was of a very dark, coarse, and somewhat brittle wax, with irregular large cells, from the size of a sparrow's egg to that of a pigeon. Westwood speaks of other exotic species composing the two genera, *Malépora* and *Trigona*, and says that insects of the latter genus build their nests at the top branches of trees, out of the reach of monkeys, in the shape of a large pear, while the former select cavities in rotten stumps of trees.

REPORT OF MUSEUM DIVISION.

Since the last report of this division was made, the entire museum has been thoroughly renovated. The large accumulation of material during the last two years necessitated additional space for purposes of exposition, and as the floor-space was fully occupied with cases, a gallery was decided upon. Plans were therefore drawn up by the architect of the building, and, upon the appropriation of $2,500 by Congress, the gallery was constructed, occupying two sides of the museum hall. The requisite number of cases to fill such a gallery were already in the possession of the department, the museum cases used for the Centennial exhibit having been planned with this object in view, and at the close of the Exhibition in Philadelphia were transported to Washington, and, in July and August, were placed in position.

The galleries extend on the north and south sides of the museum hall and are 15 feet in width, that on the north extending 102 feet, or the entire length of the museum. On the south side the vestibule of the museum-entrance divides the gallery into two sections, each 41 feet long, making an additional floor-space of 2,760 feet, or a total space, in round numbers, of 6,500 feet in the museum hall, without allowing for three staircases. The gallery is 13 feet high from the main floor of the museum to the top of the iron supports; to the floor of the gallery is another foot, leaving a space of 13 feet between it and the ceiling of the museum. The cases on the main floor, sixteen in number, reaching to the gallery, project beyond it into the center of the hall 3 feet; they are 14 feet long and 4 feet wide, and are arranged with three stationary shelves. The new cases placed immediately over them are much lighter in construction and of the same width, but in length are only 10 and in height but 8 feet. "Patent adjustable shelving" is used in these cases, together with improved graduated steps, made after designs furnished by one of the museum-assistants.

In the center of the hall, opposite the main entrace, is placed the large red-wood table surmounted by a single California plank, and on either side of it, running lengthwise up and down the hall, are four low cases, making in all forty cases for the purposes of exhibition. All the shelving and interior iron work has been repainted a bluish tint, contrasting better with the specimens than the dead white formerly used. Upon the completion of this work the department collections exhibited at the Centennial were unpacked and, with the old museum collections, arranged principally in the lower portion of the hall. Such of the specimens in the large collection of foreign donations secured at the Centennial as were already in jars, or in condition to exhibit, were brought into the museum, though fully one-half of this collection still remains unpacked. Four cases in the southeast gallery are used for the exhibition of native and foreign woods, and for objects of strictly botanical interest.

The collection embraces, first, the direct products of American agriculture, as the grains, fruits, and fibers, as produced by the farmer, with only the simple preparation necessary to market them; then the indirect products of the soil, where are exhibited the same objects after having passed through one or more stages of preparation, as the fiber spun into thread and woven into fabrics, or the grains and fruits or other vegetable products changed by chemistry or the arts into food preparations or materials used in the economic arts. A section of the museum is devoted to objects in the animal kingdom useful or injurious to agriculture, or entering into the economy of the farm, as domestic animals, poultry, game, and small birds, or the insects injurious to vegetation, comprising the natural history of agriculture.

In arranging such a collection, a classification must be adopted that is simple and at the same time comprehensive, and as it is one of the objects of an agricultural museum to give the consecutive history of a product, showing it in its various stages, as, for example, cotton from the seed to the manufactured fabric, the raw material and the prepared substance must be exhibited in close proximity. As the collection of cereal products is of the first consideration, to be of real value a large series is necessary in order that proper comparisons may be made, and as many varieties are only suited to particular sections of the country, the arrangement is necessarily by States. Thus we are enabled to trace a given wheat or barley through different portions of the country, and, rating weight and yield, to mark that State or group of States where it seems to thrive best. With foreign collections, an arrangement by countries shows at a glance the agriculture of a particular country and the comparative agriculture of different countries in relation to each other. After the collection of bread-producing substances come the fruits and vegetables, and these are arranged in a somewhat similar manner; then follow the manufacture from all of these in their varied forms, as flour, starch, sugar, &c., together with various other vegetable substances and their preparations, the whole grouped in one section as substances used for food.

The materials used exclusively in the economic arts or in manufacture, as the textile fibers, paper-making materials, coloring and tanning substances, oils, gums, resins, &c., and the objects made from them, including also a few substances closely related from the animal and mineral kingdoms, are grouped in other sections. Here we are enabled to show comparatively, the products of different sections of the country or of the world as used in the mechanic arts, and to trace them step by step through all their changes, showing the farmer or the general observer just what portions of a plant, or what kind and quality of wool, enters into the construction of a particular fabric.

In a third section are grouped the animals, birds, and insects, showing the true types of domestic poultry and their supposed origin; our game birds that have been or may be domesticated or introduced from other countries, the small birds arranged in their relation to agriculture as to their benefit or injury; and lastly the grand army of noxious or beneficial insects.

A fourth group illustrates practical botany by collections of native and foreign forest-woods, &c., carpological collections, and specimens of fibers, fruits, seeds, &c., of strictly botanical interest; and into a fifth section are grouped fertilizers, soils, farm implements, and miscellaneous objects that can have no place in the foregoing sections.

A museum of this character should be for utility, and not for mere exhibition as a free show-room. In the first place, it is an object library, where, consulted in connection with the conservatories or arboretum, questions may be at once answered upon the entire history of most of our vegetable products. Nor is the mere labor of arranging the specimens in cases the principal work of the museum. The history, description, uses, and methods of preparation of its many interesting products should be gleaned, new facts added, study and examination made—with the microscope where necessary—and this valuable information given to the public in a form that will enable those who never visit the department to avail themselves of the benefits of its collections. In addition, there are new and interesting fibers that may be utilized, gums and resins that may contain some unknown useful element to be examined and tested, and many other products that in a mere exhibition-room might lie upon a shelf a meaningless object for ages; and only such putting the museum into imperishable record will bring out this *knowledge* and make it truly useful, or answer the ends for which it was established.

The following is a systematic classification of the museum, from a study of the museum itself, and relating only to the material it at present contains:

ECONOMIC MUSEUM OF AGRICULTURE.

Systematic classification.

Section A.—Food substances.

SUBSECTION I.—CEREALS AND LEGUMES.

a. Cereals.

Wheat, maize or Indian corn, rye, barley, oats, buckwheat, and rice, native and foreign.

(These and the following specimens in this subsection are arranged by States or by countries.)

b. Small grains and seeds.

Millet, sorghum, &c.

(The grass-seeds are also included in this subsection.)

c. Legumes.

Beans, pease, &c.

SUBSECTION II.—FRUITS AND VEGETABLES.

a. Without preparation.

Models in plaster, papier-maché, &c.

Preserved as specimens in alcohol, brine, &c.

b. Prepared for food.

Edible nuts, as almond, walnut, pecan, &c.

Dried fruits—apples, peaches, &c., figs, raisins, &c.

Canned fruits.

Preserves.

SUBSECTION III.—FARINACEOUS SUBSTANCES.

a. Grits.

Cracked corn and hominy, cracked and crushed wheats.

Avena or oaten grits, farina (Hecker's), &c.

Pearl barley.

b. Meals.

White and yellow meals from Indian corn.

Rye, Graham and oat meal.

Meal of plantain, cassava, &c.

c. Flour.

Wheat, rye, and buckwheat flours.

Rice-flour.

Flour from dried tubers of sweet potato.

d. Starches.

A.—USED AS FOOD.

Corn-starch, maizena, and other cereal starches.

Starch from cassava, farina from bread-fruit.

Arrowroot, sago, tapioca, mandioca, &c.

B.—USED IN THE ARTS (placed provisionally in Section A).

Potato, wheat, and other starches used for sizing; dextrine.

e. Miscellaneous.
Complete series illustrating the manufacture of flour.
Split pease, dried sweet corn, &c.
Bread made by natives of Santo Domingo, and other specimens.

SUBSECTION IV.—SUGAR AND SIRUPS.

a. Sugar-cane.
Raw and refined sugars, native and foreign.
Molasses, sirups, drips, &c.
b. Sorghum.
Raw and partially refined sugars from Northwestern States.
Sirups.
c. Beet-root.
Models of the sugar-beet.
Dried sliced root, first stage of manufacture.
Crystals, loaf and granulated sugars, native and foreign.
d. Maple.
Cakes and granulated sugars.
Syrup.
e. Miscellaneous.
Sugar manufactured from corn-stalks.
Sugar of milk.
Glucose.

SUBSECTION V.—BEVERAGES, LIQUORS, AND NARCOTICS.

a. Tea.
Varieties of leaf-tea from Japan and China.
Substitutes for tea (Japanese) and probable adulterations.
Maté or Paraguay tea.
Cocoa (*Erythroxylon*).
b. Coffee.
In berry, various countries.
Preparations.
Substitutes and adulterations (chicory, &c.).
c. Cocoa.
Cocoa beans and seed-pod, or envelope.
Cocoa "shells."
Preparations—cocoa, broma, chocolate, &c.
Sweetened chocolates are also included here.
d. Vinegar and wines, or products of fermentation.
e. Liquors produced by distillation.
(Groups *d* and *e* not represented at present.)
f. Narcotic stimulants.
Tobacco:
Native and foreign leaf-tobacco.
Prepared leaf for chewing and smoking; snuff.
Opium, when used as a stimulant.

SUBSECTION VI.—SPICES, CONDIMENTS, &C.

a. Spices.
Nutmeg and mace, cloves, cinnamon, allspice, ginger, cayenne and black pepper.
b. Aromatic seeds.
Anise, caraway, coriander, cardamom, &c.

c. Substances for flavoring, pot-herbs, &c.
Vanilla bean, &c.
Sage, marjoram, thyme, basil, mint, tansy, &c.

d. Table oils, vegetable sauces, &c.
Olive oil and its substitutes (peanut oil).
Japanese soy and other sauces.
Catsups and prepared horse-radish.

SUBSECTION VII.—ABORIGINAL FOOD SUBSTANCES.

a. Cereals and seeds. (Natural state and prepared.)
Maize, native varieties; wafer bread from blue corn.
Wheat and other cereals, grass seeds.
Mesquite and screw beans, natural state, pounded into coarse meal, made into bread.

b. Nuts, dried fruits, &c.
Piñon, acorns, &c.
Berries, dried or pressed into cakes.
Grapes and stone fruits.
Fruits of cactus and yucca, dried and preserved.
Muskmelon, pumpkin, &c., dried in strips.

c. Roots, leaves, &c.
Kouse root, tubers, sliced and dried, bread or cakes.
Kamas root, tubers, rude cakes.
Wild potatoes (*Solanum*).
Leaves (inside) of Agave, roasted and preserved.
Hops, sugar from Labba cane (Mexican).
Liquor distilled from Agave, "Mescall."

d. Miscellaneous substances (not vegetable).
Jerked beef.
Insects, dried and prepared.
Eggs of fish or animals, dried.
Blue clay (containing magnesia), eaten with potatoes.

Section B.—Substances used in the Arts and Manufactures.

SUBSECTION I.—TEXTILE FIBRES.

A.—ANIMAL FIBERS.

a. Wool from sheep.
Wool clips, washed and unwashed.
Fine wools. (Principally used for clothing.)
Long wools. (Principally used for worsteds.)
Coarse wools. (Used in carpet manufacture.)
Manufactures:
Dyed fleece. (Sometimes used as trimmings.)
Spun-wool, yarns, and worsteds.
Flannels and piece goods, shawl manufacture.
Feltings, including druggets.
Rude manufacture of aborigines, blankets.
Miscellaneous objects.

b. Wool from goats.
Angora or Cashmere, fleece and fabrics.
Rocky Mountain goat, fleece.

c. Hair from various animals.
Camel, llama, and fine hair.
Cow and calf hair.

d. Silk.

Bombyx mori, native and foreign:
Cocoons, mulberry and osage-orange fed.
Reeled silk.
Manufactures.
Spun and dyed, for embroideries and weaving.
Fabrics, including jacquard weaving.
Silk-gut and miscellaneous manufactures.
Foreign silk-producing insects (other than *B. mori*):
Bombyx pernyi, cocoons, reeled silk, and fabric.
Bombyx yama-mai, cocoons, and reeled silk.
Bombyx mylitta, cocoons and silk.
Bombyx cynthia, cocoons, silk and fabric.
Miscellaneous.
Native silk-producing insects:
Samia cecropia, cocoons, silk, and silk-gut.
Telea polyphemus, cocoons.
Tropœa luna, cocoons.
Platysamia promethia, cocoons.
Bombyx cynthia (introduced), cocoons.
Miscellaneous.
Silk produced by other insects and by spiders:
Ichneumon silk.
Silk made by various spiders, as *Nephila plumipes.*

B.—VEGETABLE FIBERS.

I. *Fibers suitable for spinning and manufacturing purposes.*

a. Cotton.

Lint cotton, (including seed-cotton and cotton bolls):
Long staple or sea-island.
Short staple or upland.
Tree cotton, or perennial.
Manufactures:
Miniature bales, as baled for market.
Cleaned, carded, and spun (10 processes).
Fabrics, including spool-cotton.
Home production (100 years ago) and rude manufactures.

b. Flax.

Raw.
Raw or partially prepared:
Flax-straw, rotted and broken, tow and line.
Manufactures:
Various processes of manufactured linen goods, &c.
Flax-cotton fiber and fabrics.
Flax-wool fiber in stages of preparation.

c. Ramie.

Specimens of plants showing leaves; stalks as grown.
Raw fiber, as stripped from stalks, partially prepared.
Various stages of manufacture.
Fabrics composed wholly of ramie, or mixed with other fibers.

II. *Fibers suitable for spinning and manufacturing purposes, but of inferior durability or coarser texture.*

d. Jute.

Jute in raw state, jute butts, &c.
Prepared fiber and manufactures.
Gunny-bags, carpets, crash, tapestry, &c.

e. Malvaceous fibers.
Raw and prepared fiber of *Hibiscus esculenta, H. subdarifta, H. sinensis*, &c.
Stalks and fiber of *Abutilon avicennæ.*

f. Miscellaneous fibers (prepared experimentally).
Asclepias, stalks, fiber, fabric (one-half cotton.)
Epilobium, fiber and manufacture.
Pinus sylvestris, or vegetable flannel.

III. *Fibers chiefly used in the manufacture of cordage, twine, &c., but sometimes woven or beaten into cloth, or used for miscellaneous purposes.*

g. Foliaceous fibers.
New Zealand flax, *Phormium tenax:*
Leaves and partially prepared fiber.
Manufactures, as rope, twine, nets, matting, and cloth.
Agave or aloe fibers:
Agave sisalana, Sisal hemp, leaves, fiber.
Specimens of Fayal lace-work.
Agave Americana, fiber, mats, brushes, &c.
Fourcroya cubensis, leaves and fiber.
Manila hemp:
Leaves, raw and prepared fiber of *Musa textilis.*
Screw-pine:
Fiber of *Pandanus odoratissimus.*
Pine-apple:
Leaves and prepared fiber of *Ananassa sativa.*
Yucca:
Raw and prepared fiber, rope and paper from *Yucca gloriosa, angustifolia*, &c.
Corn-husks:
Husks, fiber, crash, oil cloths, and paper.

h. Miscellaneous coarser bark fibers.
Hemp:
Raw and prepared fiber, rope and cordage.
Apocynum:
Stalks, raw and prepared fiber of *Apocynum cannabinum.*
Mats, bags, baskets, nets, &c., made by Indians.

i. Lace barks and tapa.
Brousonetia papyrifera, tapa cloths, &c.
Bark of *Daphne tenuifolia, Lagetta lenteria*, &c.
Leaves of *Celmesia coriacea.*

IV. *Fibers suitable for the manufacture of very coarse cordage, mats, or for upholstering purposes, including silk-cottons.*

j. Coarse fibers, various uses.
Coir, or cocoa-nut fiber, raw and prepared; spathe; "hats," mats, matting, rope, brushes, and imitation hair for upholstering.
Attalea funifera, fiber used for brushes and brooms.
Xylopia sericea, made into rope for tying cattle.

k. Fibers for stuffing or upholstering only.
Southern moss, *Tilandsia usenoides*, "hair."
Pulu, *Cibotium menziesei*, a fiber from the tree fern, known as "pillow-wool."

l. Silk-cottons or "downs."
Bombax (species), pods and "silk."
Asclepias, pods and down; "vegetable silk."
"Down" from poplar tree.

V. *Miscellaneous substances,* not strictly fibrous, when manufactured, plaited, or coarsely woven into hats, sacks, baskets, &c.*

m. Grasses and reeds.
Tule, used as cases for wine-bottles.
n. Palm leaves.
Split leaves of fan-palm, made into sacks and mats.
o. Cane and bamboo.
Split bamboo, baskets, fans, &c.

SUBSECTION II.—PAPER MATERIALS.

a. Writing and printing papers.
- Pure rag (cotton and linen):
  - American linen, cotton and linen rags, pulp, and papers.
  - Flat papers, cotton rags, pulp, paper.
- Rag and paper:
  - Flat paper, colored rags, and waste paper, pulp, and manufacture.
  - Book and news, colored rags and paper, pulp, papers.
  - Cover papers, the same.
- Wood:
  - Maple wood and sample of printing-paper.
- Esparto:
  - Fine printing-papers, grass, pulp, and paper.
- Maguey:
  - Drawing-paper from leaves of agave.
- Palmetto:
  - Printing-paper, leaves and paper samples.
- Okra:
  - Printing-paper (coarse); stalks, pulp, news paper.
- Husk:
  - Various papers; corn-husk, pulp, and manufacture.

b. Wrapping and coarse papers.
- Manila:
  - All-rope; complete stages of manufacture, flour-bags.
  - Manila wrapping; old rope, gunny-sacks, and waste paper, pulp, manufacture.
  - Bogus manila; gunny-sacks, waste paper, straw pulp, paper.
- Straw and grass:
  - Straw-wrapping; straw, pulp, paper in variety.
  - Spartina grass (*S. cynosuroides*); grass and paper.
  - Hay, sample of paper.
- Yucca (*Yucca angustifolia*):
  - Stalks of yucca, various samples of paper.
- Cane:
  - Canebrake, fiber and paper.
  - Sorghum, sample of paper.

c. Miscellaneous substances capable of manufacture.
In this division are included those fiber-producing plants from which paper has been made, but not generally used as paper materials in this country; includes paper from ramie.

d. Chinese and Japanese papers.
- Mulberry, bamboo, and straw papers.
- Fancy papers for screens, &c.
- Imitation leather.
- Rice paper, *Aralia papyrifera*.

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* A considerable collection of fibers belonging to this group have yet to be identified and placed in the collection, used for making hats, twisted ropes, &c.

SUBSECTION III.—DYES AND COLORING MATERIALS.

a. Vegetable origin.
  Roots:
    Madder, tumeric, &c.
  Woods, bark, and leaves:
    Indigo, fustic, logwood, quercitron, &c.
  Flowers, seeds, or fruit:
    Saffron, arnotto, &c.
  Lichens:
    Species of roccella.

b. Animal origin.
  Cochineal insect (*Coccus cacti.*)
  Chermes, &c.

c. Mineral origin.
  Aniline dyes and coal-tar products, &c.

SUBSECTION IV.—TANNING MATERIALS.

d. Barks, leaves, galls, whole plants, woods, &c.
  As much material that would be classed in this subsection remains unpacked at the present time, its place is merely indicated, without attempt at classification.

SUBSECTION V.—GUMS AND RESINS.

a. Gums.
  Mucilaginous gums, as tragacanth, acacia, dragon's blood, &c.

b. Oleo resins.
  Copaiva, various balsams, "black varnish," camphor, &c.

c. Gum resins.
  Assafetida, ammonia comp. myrrh, &c.

d. Resins.
  Pine resins, mastic, dammar, burgundy pitch, &c.

e. Lacs.
  Various resins produced by punctures of insects.

f. Elastic gums.
  Caoutchouc or India rubber, gutta-percha, balata.
    Manufactures from same.

SUBSECTION VI.—FATS, OILS, WAX, &C.

A.—VEGETABLE ORIGIN.

a. Vegetable tallow and wax.

b. Fixed oils.
  Linseed, cotton-seed, castor-bean, croton oil, &c.
  Almond, walnut, olive, and palm oil, &c.
    Manufactures from above, soaps, &c.

c. Essential oils.
  Oil of hemlock, wintergreen, peppermint, sassafras, bergamot, pennyroyal, &c.

B.—ANIMAL ORIGIN.

d. The animal fats and oils.

e. Beeswax.
  Soap, candles, and various manufactures.

C.—MINERAL OILS, &C.

e. Petroleums and coal-oils.

f. Bitumen.

Section C.—Natural History in Relation to Agriculture.

SUBSECTION I.—ANIMALS.

a. *Domestic animals.*
Stuffed types of farm animals (none at present in the museum).
b. *Animals found upon the farm in wild state.*
Those animals denominated as "farm pests," or those useful by destroying insects, or as furnishing food. Among those may be named rabbits, foxes, mice, squirrels, skunks, &c.

SUBSECTION II.—BIRDS.

a. *Domestic poultry.*
Types of various breeds of chickens, ducks, geese, turkeys, &c., together with pigeons.
b. *Game birds.*
Fowls, showing origin of domestic poultry.
Hybrids.
Game birds of the United States.
Foreign game birds that have been or may be introduced, pheasants, &c.
c. *Birds—beneficial or injurious.*
Small birds shown with contents of the stomach.
(The end of each perch is colored white or black to show the proposed proportions of benefit or injury.)
Owls and rapacious birds.

SUBSECTION III.—INSECTS.*

a. *Economic collections.*
Native insects injurious to vegetation, arranged in regard to the plants on which they feed, showing various stages and parasites, together with artificial means of destruction.
b. *Scientific collection.*
Native insects arranged according to classification.
Foreign insects in all orders.
Microscopic slides of minute insects and insect anatomy.
c. *Curiosities (arranged for public exhibition).*
Gaudy or striking forms of insects, native and foreign.
Curious specimens of insect architecture and injury.
d. *Plates.*
250 colored plate-engravings of insects in all orders, together with their larvæ, pupæ, and cocoons where known.

Section D.—Botanical Series.

SUBSECTION I.—FOREST WOODS.

a. *Sections of forest woods of the United States.*
b. *Sections of forest woods, foreign.*

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*The cabinet of entomology is exhibited in Room 20, adjoining the museum, and the collections are arranged in three large cases built on the same pattern as the museum lower-cases.

SUBSECTION II.—VEGETABLE PRODUCTS OF BOTANICAL INTEREST.

a. Roots.
b. Barks.
c. Fibers.
d. Miscellaneons specimens.

SUBSECTION III.—CARPOLOGICAL COLLECTIONS.

a. Cones.
b. Acorns and nuts.
c. Leguminous fruits.
d. Soft fruits.
e. Capsules, and miscellaneous fruits and seeds.

Section E.—Miscellaneous Collections.

SUBSECTION I.—VEGETABLE SUBSTANCES USED IN MEDICINE.

a. Roots, barks, and woods.
b. Leaves, flowers, and fruit.
c. Preparations.
Extracts and tinctures, as laudanum, &c.
Approximate principles, morphine, quinine, &c.

SUBSECTION II.—SOILS.

(The present collection, principally American soils, has not been classified or arranged.)

SUBSECTION III.—FERTILIZERS.

a. Vegetable origin.
Sea-weeds, peat, or muck, &c.
b. Animal origin.
Fish and other guanos, animal refuse, &c.
c. Mineral origin.
Phosphates, marl, greensand, lime, gypsum, &c.

SUBSECTION IV.—FARM IMPLEMENTS.

Models of farm machinery.
(The present collection is also quite small and incomplete.)

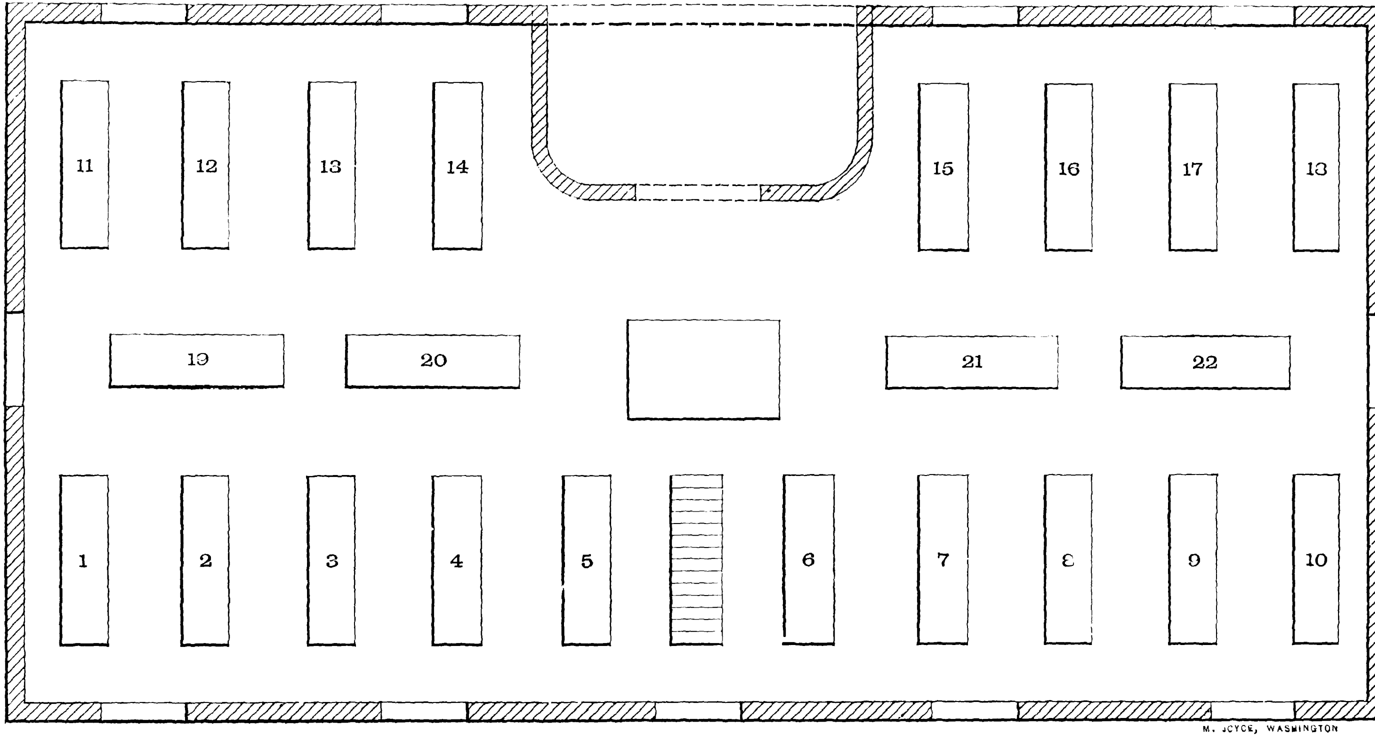
SUBSECTION V.—CASTS ILLUSTRATING DISEASES OF FARM ANIMALS.

Cattle.
Casts of stomach and other portions of the body as they appear in Rinderpest.

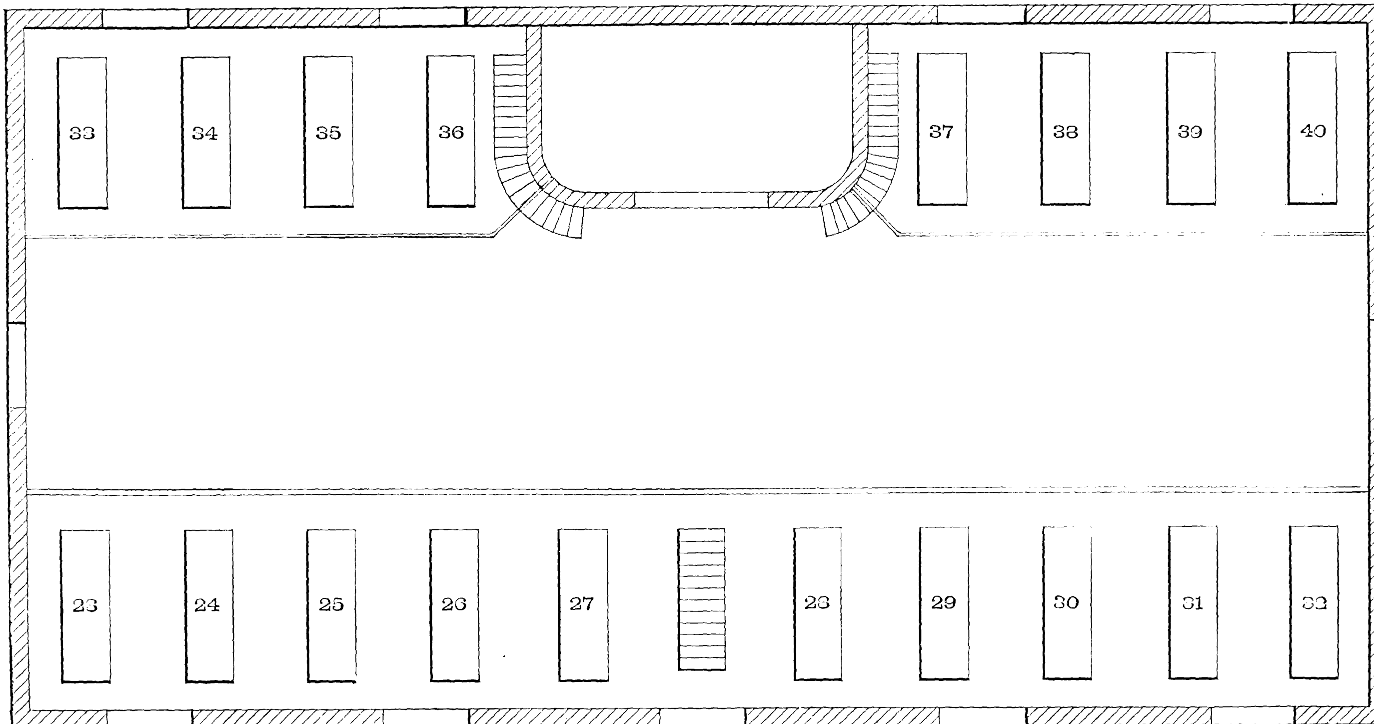
PLAN OF THE MUSEUM.

To give a better idea of the relative size of the museum and the number and position of the cases, the accompanying diagrams have been prepared, and the various collections, according to the above classification, are disposed in the following manner:

The cereal collections are arranged in the northeast portion of the



Plan of Museum. Main Floor.



Gallery in Museum.

museum, occupying eight cases—three upon the main floor and five above. In Case 1 are arranged the specimens of grain collected at the Paris Exhibition of 1867, with a few specimens of English and French grain upon the upper shelf. Case 2 is occupied by a large collection of maize. The specimens on the first and second shelves are exhibited on black wooden tablets, while the shelled corn, placed in glass jars, occupies the shelf above. Wheat, rye, barley, oats, and buckwheat occupy Case 3, and Cases 23 to 27 in the gallery above are filled with foreign cereals, secured at the Centennial, but not yet classified. The farinaceous products are placed in Case 4, a few specimens of grass-seeds, rice, and legumes occupying the lower shelf.

Case 5 is devoted to American and foreign tobacco, the foreign samples placed below, the American leaf-tobacco, in uniform boxes, occupying the middle shelf, while the top of the case is devoted to the manufactures exhibited in glass jars. In Cases 11 and 19 to 22 are arranged the large series of fruits and vegetables modeled in plaster, the last four being low cases with glass tops. Cases 12 and 13 are occupied by fruits in alcohol, sugars and sirups, beverages, liquors, &c., spices, condiments, &c., and aboriginal foods. The paper collection has been arranged in Case 14, the American samples occupying the middle shelf, the Japanese samples the third shelf, while the remaining foreign samples are placed below. Textile fibers occupy the entire southwest portion of the museum, and are arranged in the following order: Silk, Case 15; wool, Case 16; ramie and flax, Case 17; cotton, Case 18; Case 37 (gallery), jute, malvaceous, and lace-bark fibers; 38, 39, and 40 miscellaneous, vegetable fibers.

The natural-history collections, excepting the insects, are placed on the main floor in the northwest portion of the hall. Case 6 is devoted to animals (farm pests or small animals found upon the farm), and 7, 8, and 9 are occupied by domestic poultry, game birds, &c. Case 10 is occupied by the collection of small birds beneficial or injurious to agriculture, and to the larger birds of prey, as hawks, owls, &c. The remaining cases in the northwest gallery (Nos. 28 to 32) are devoted to gums and resins, oils, fats, wax, &c., dyeing and tanning material, specimens of materia medica, and the miscellaneous collections enumerated in Section E. This portion of the museum, however, has not at present been systematically arranged, although a majority of specimens have been placed on exhibition. The gallery cases in the southeast portion are devoted to the collection of forest woods and botanical objects; they are numbered 33, 34, 35, and 36. The center of the hall is occupied by the large redwood table, from one California plank, and supports an ornamental vase hewn from coquina or shell-rock of Florida, and filled with native ornamental grasses. The entomological room is just west of the museum hall, and is provided with three walnut show-cases similar to the fruit-cases in the museum. Upon the walls are displayed a portion of the economic collection of insects prepared for the Centennial, together with the elaborate collection of copper-plate engravings, numbering some 260 plates.

FOOD-SUBSTANCES.

Cereals and legumes.—During the last two years the additions to the collections of grains and cereals have been very large. From our own country a collection of over eight hundred specimens of maize, wheat, rye, barley, oats, buckwheat, beans, pease, &c., gotten together as the grain exhibit of the department at the Centennial, has been given place in the museum. The specimens were carefully selected from particular localities in the different States by correspondents of the department, who were desired to send only the principal varieties best suited to their respective localities. The collection is thus a fair exhibit of the cereals of the United States grown in 1875. In glancing over the collection of wheat, a few prominent varieties, as the Tappahannock, Mediterranean, Fultz, Lancaster, &c., are observed to be of general culture, while others seem to be grown exclusively in a certain State or section. In some instances it is probable that old varieties have been given new names as there are many names with but a single specimen occurring in the whole collection.

In the New England States we find the Lost Nation, Tappahannock, and Lancaster Red Chaff the most commonly cultivated; while samples of Arnautka, Canada, Hybrid, White Laisette, and White Italian occur. New York adds Diehl, Treadwell, China Tea, and other varieties. In the remaining Middle States and Maryland, Virginia, and North Carolina we find Fultz and Mediterranean grown; Tappahannock, White Canada, and Golden Chaff are also represented. Ohio has sent nearly the same wheats as are grown in Pennsylvania, only one name not previously occurring, that of "Todd" wheat, being observed. Indiana and Illinois grow Lancaster, Michigan, Amber, Tappahannock, Odessa Red, Fultz, China, Missouri, Velvet, Early, Oran, Scotts, Egyptian, and two or three other varieties. In the Missouri collection we still find Fultz and Odessa, together with New York Flint, Independent Spring, &c. Iowa contributes Rio Grande, Canada, Fife, and White Chili. Among the varieties grown in Minnesota are Scotch Fife, Rio Grande, and China Tea, before mentioned, with the addition of Eureka, Early Sherman, and White Hamburg. Michigan sends Diehl, Gold Medal, and White Mountain.

The wheats of Kansas and Colorado, approaching in appearance those of California, are White Colorado, White California, Turkey, and Colorado Red Chaff, while Nebraska gives the names of Priest Spring, Otoe, and Russian Club. Among the wheats of the Pacific coast, principally white wheats, the White Australian appears to be the general favorite. The White Chili is also grown, and such varieties as Canada Club, Jones, Propo, Bride of Butte, and Nonpareil are represented in the collection. From Texas and New Mexico we have Sonora and Zaragoza. From the remaining Southern States the collection of wheats is very meager.

In this series there are but 35 samples of rye from various localities throughout the United States. The most interesting specimen is the Montana rye, which, in color and size, resembles a wheat, but has the form and characteristics of rye. It was first sent to the department from Montana, under the name of Goose wheat. The berry is quite large and very hard, and is said to make a superior flour.

Among the oats, the Norway, White Shonen, Surprise, and Probstier seem to be the favorites, the three last named having been introduced by the department. There is also a specimen of the so-called hull-less oats; barley and buckwheat are tolerably well represented, and there are a few specimens of sorghums and grass-seeds. The collection of pease and beans is quite small, but represents the leading varieties in cultivation.

The foreign collections of grain are quite large, and embrace a score of countries, scattered over the globe. As has been previously stated, many of these specimens have not yet been placed in the museum, and none of them have been examined. From a casual observation it is to be inferred that the finest foreign specimens, especially of wheat, are to be found in the Australian group. Specimens were secured from Victoria, weighing from 61 to 68 pounds per bushel. New Zealand has also some remarkably fine white wheats.

A very large miscellaneous collection of agricultural products from the Netherlands contains a number of fine samples of oats and barley; there are a few good wheat samples, but a large part of the collection is made up of beans, pease, millets, &c., in variety. In the Peruvian collection there are several varieties of very large maize, similar to the Caragua corn sent out by the department a few years ago; some of the grains are nearly an inch long; it is exceedingly light in weight, consisting almost wholly of starch, and is very inferior in quality. From the Chilian department a very fine grain collection is secured. The wheats and barley are especially fine; the collection includes, in addition to the principal cereals, vegetable and other seeds, a great variety of edible nuts and other vegetable products.

From Peru, Argentine Republic, and Brazil, there are limited grain collections, pease and beans being more fully represented. Interesting collections have been added from Turkey, Spain, Portugal, Norway, and Sweden, which fully illustrate the agriculture of those countries, the cereals forming the principal parts of the collections. A small series of Russian cereal productions have been secured, but together with the collections from Spain, Portugal, South Australia, Victoria, Queensland, Tasmania, Egypt, Brazil, and Mexico, have not been unpacked further than to examine the contents of the bags to learn their condition. More than half of the countries presented their collections as exhibited in the original jars, and such collections were placed without further preparation upon the museum shelves.

A series of 1,400 specimens secured at the Paris Exhibition of 1867, and representing 22 countries of Europe, Asia, and Africa, is worthy of passing mention. The collection occupies two-thirds of Case No. 1, on the floor of the museum. The upper portion of this case is filled principally with French and English cereals secured from various sources, many of them being samples of grain either sent out by the department or offered to the department as varieties worthy of dissemination in this country. The fine collection of 200 specimens of wheat, rye, barley, oats, sent by Vilmorin Andrieux & Co., Paris, seedmen, is still in good state of preservation. They are put up in glass tubes, and exhibited with a head of the grain, the whole mounted in walnut cases 2 by 3 feet, and covered with plate-glass. One of the ten cases has been somewhat injured by insects, though the remainder have been thoroughly cleaned and are in perfect order.

Fruits and vegetables.—This class of agricultural products is chiefly represented in the museum by models made of plaster soaked in boiled linseed oil and painted in oil colors. Wax has been tried, but not found permanent; the volatile part evaporating, and the model shrinking, is destroyed.

A collection of tropical fruits made of *papier-maché* was purchased in 1871, and others have been made of various compositions to test their value for modeling purposes, but nothing has been found superior to plaster for the class of work required.

For models of large size, compositions of which paper-pulp is the basis may be employed with advantage.

The original specimens are obtained by donation or purchase, and are selected to illustrate the horticultural products of the country in all their marvelous variety, not only by single specimens, but by a sufficient number of each kind to show the modification caused by soil and climate, which have in the United States a wider range than in any other nation in the world, except perhaps Russia. A collection which should give a full representation of all the fruits and vegetables that may be produced in this country and used as food for man, would exhibit a variety and richness as yet undreamed of.

The specimens in such a collection are imperishable, except by the destruction of the building containing them, and will offer to the future cultivator the means of solving many problems that are now only matters of conjecture. It is a favorite theory of some horticulturists that the life of a variety, propagated by buds or grafts, is dependent on and limited by that of the original tree, or at least that the period during which it will thrive and may be profitably cultivated has some natural limitation. A collection of models, allowing comparisons to be made in future of actual specimens with *fac-similes* of those grown many years previously, will, we think, demonstrate the utter fallacy of this theory, by showing that deterioration in the quality of a particular kind is usually local and often temporary, and that conditions of growth similar to those surrounding the parent stock will produce results of equal excellence; hence, that the life of a variety may be indefinitely prolonged.

The cultivated fruits now in use have unquestionably been derived from certain wild species, and it is very probable most of the modification has taken place since the historic period, if not since the Christian era. It may sound like a frivolous chimera to suggest the possibility of a collection of fruit-models enduring for centuries, and yet articles of a more perishable nature are now among our most certain historical records, and if we could find a few models of the fruits known to the Greeks and Romans they would aid us much in the solution of some of the most interesting and important questions of fruit-culture. The models now in the museum represent more than 400 varieties of the apple, 300 of the pear, 150 of the plum, about 100 of the principal tropical fruits, and nearly 200 melons, potatoes, &c. Of the standard kinds of apples and pears there are numerous duplicates, swelling the number of models to nearly 2,000, making a perpetual fruit-show that may be studied at any season. The largest apples grown are Gloria Mundi, which appear to thrive in all parts of the Union, though nowhere considered a profitable market fruit.

The heaviest apple whose model we now have in the collection weighed 29 ounces, and grew in Nevada; but a little heavier one from Oregon has since been received.

A comparison of specimens from all parts of the country shows that apples originating in the Eastern States usually gain in size when grown in warmer parts of the West, but lose something of intensity of color, and perhaps of flavor. Varieties differ greatly in amount of variation, the Baldwin changing most of all.

The hilly portions of the Southern States have repeatedly sent us as fine specimens of apples as can be produced anywhere else, and even in the extreme South, along the Gulf, there are certain varieties, like the Green Cheese, that thrive, and keep "till apples come again." The keeping quality, however, in apples grown on the Southern lowlands is the exception, not the rule.

We frequently receive certain interesting monstrosities that seem not uncommon in the apple. Among them are twin or triplet apples, two or three grown in one; the Surprise apple, with red flesh, occurring in Wisconsin; apples having one side russet and the other smooth, the line of division being very straight and distinct, usually from stem to eye, but sometimes transverse. These are the apples sometimes reported to result from uniting the halves of buds from two different varieties in inoculation, but there is nothing whatever in the history of the trees producing these specimens to confirm this theory. Apples are sent to us from Plainfield, Mass., that are strongly pear-shaped, growing on the same branch with round ones; but perhaps the most interesting curiosity of all is a coreless apple, in which the fruit is turned inside out, leaving a small cavity open to the air where the core should be, while rudimentary seeds are produced on the outside of the apple.

The collection of models of pears contains nearly every variety of standard excellence. Compared with the apple, new kinds are seldom brought to public notice, notwithstanding the high price paid for first-class fruit. There are, no doubt, many varieties which, when grown as standards, are more regular in bearing than the apple, but the additional care required in ripening and keeping them in winter seems likely to prevent cultivators in general from giving this fruit the attention it justly deserves. Many visitors to the museum are surprised by the exhibit of three pears from Clackamas County, Oregon, the originals of which weighed four pounds each, and measured in circumference, respectively, 18 and 20 inches.

We have several times received specimens of a quince weighing from two to three pounds, said to come from Japan, but which is entirely different from the fruit of the flowering Japan quince (*Pyrus Japonica*) It is probably the Portugal quince, which is of excellent quality, but whose shy habit of bearing has hitherto prevented it from finding favor with cultivators.

Our plums are chiefly from the Hudson River region, where, with a part of Western New York and New England, this fruit is more in cultivation than anywhere else in the United States. A small fruit from Japan, called the Japanese plum, is much grown near New Orleans, where it ripens early in winter and is a great favorite. Its Asiatic name is Li-tchi or Longan, and it is not a plum at all, botanically speaking, but belongs to the sapindaceæ or horse-chestnut family. There are many varieties of this fruit cultivated in China, some of which are described as much larger than any we have received, and it is doubtful if the best kinds are yet in cultivation here.

The models of cucurbitaceous fruit include the melons, squashes, &c., usually grown, with some comparatively rare. The number of varieties in this family is immense, and a caprice akin to fashion often seems to influence the amount of popular favor granted to certain kinds. Queen Anne's pocket-melon, a small musk-melon once in high repute, was so nearly extinct that a few seeds only were preserved by accident. Not long ago the Japan apple-pie melon was extensively grown, but is now almost unnoticed. Among the rarer specimens in our collections is the Soolyu, a Chinese cucumber as large as a water-melon, introduced into Europe some time ago, the cultivation of which does not, however, appear to extend. From New Orleans we have the banana-squash, the flavor of which is said to resemble a banana. It is from four to six pounds in weight, shaped like a cucumber, and of an orange color. The snake-squash, usually grown as a mere curiosity, has been brought to us as a candied preserve of such superior excellence as to deserve particular notice.

Among the models of eighty varieties of the potato are some of the tubers of *Solanum Fendleri* of New Mexico. These tubers were quite small when first received, but increased very much in size during three years of cultivation. There are nearly one thousand species of the genus *Solanum*, many of which have edible tubers, besides *S. tuberosum* (the common potato), and it is not at all impossible that species not now in cultivation possess qualities worthy of attention.

Although the Indians use considerable quantities of the cactus fruits of our Western plains, it is hardly probable they will ever be considered worth cultivation by us. The fruit of the European prickly pear (*Opuntia ficus Indica*) is frequently eaten in Spain and Italy, and the specimens we have received from the Mediterranean are much larger and more attractive than any of our native fruits of that family.

Most of the principal tropical fruits are represented in the collection, many of which are already grown in the extreme southern portions of the Union. Pre-eminent among these are oranges and lemons, of which California sends the finest specimens yet received; the banana, mango, South American pawpaw, &c.

It is certain we are very far from employing the full capacity of our soil and climate in the production of fruits of the warm temperate zone, for we have as yet no adequate representation of the orange family alone. The quality of our production is established by the high price Florida oranges command in our markets compared with those brought from Europe, to which they are much superior in size and flavor.

Numerous inquiries, both official and private, have been received from time to time as to the method of making plaster models of fruit. The process is essentially simple, depending more on the mechanical tact and artistic skill of the operator than any intrinsic difficulty. The tools and materials necessary are some common bowls, spatulas, fine sand, calcined plaster of Paris of the best quality, boiled linseed-oil, artist paint-brushes, and tube-colors, such as are used for painting on canvas. The apple or pear of which a model is required is buried in a bowl of sand so as to expose precisely one-half the fruit, the surface of the sand touching its largest diameter. The bowl or other vessel should be three-fourths of an inch larger all round than the specimen, which is now covered to the depth of half an inch or more with plaster mixed to the consistence of thick cream. In about fifteen minutes this coat will set, when the half mold and specimen may be lifted out of the sand, some of which will probably adhere to the moist surface, and should be brushed off. In order to secure that the second half of the mold shall accurately fit the first, a notch is cut in the upper edge of the latter and three small nails driven in at equal distances. The edge of the mold is oiled, and sufficient plaster poured on to make the second half. In an hour or two it will be hard enough to permit the separation of the two parts by tapping a cold-chisel inserted in the joint, when the fruit is removed, leaving a perfect fac-simile mold of the original. The inside of this mold must be thoroughly oiled, then filled with plaster, each half separately, a little more than full, and when the two parts are pressed together the surplus material will be forced out between the halves of the mold. Whenever the models are large enough to admit of it the soft plaster is spread up the sides of the mold with a spatula, so as to leave the central portion hollow, $\frac{3}{4}$ to 1 inch being a sufficient thickness for the model, which, when very long and slender, or very large, is strengthened by inserting stout wires in its substance. In a few hours the cold-chisel may be again used to separate the mold, when a perfect model should be obtained, only marred by a thin band at the parting of the mold, which must be pared off with a knife. Various kinds of oil or compositions are used as parting fluids. We prefer a mixture of paraffine and lard-oil. Warm a pint of oil and dissolve in it half an ounce of paraffine, stirring it occasionally till perfectly mixed, when it will remain ready for use. The proportion of paraffine may be varied without detriment according to the season. The oil will soak into the plaster and leave a smooth, delicate coat of paraffine on the surface.

The most usual imperfections are air-bubbles. These can only be avoided by skill in manipulation. In mixing the plaster it may be sifted through the fingers into the water, stirring as it thickens, or the water may be poured in a given quantity of plaster. The first methods permits the escape of air more readily than the second. Beginners usually mix the plaster too thick; it should flow readily, but should contain no free water to run over the top. By shaking some thin plaster over the surface of the mold, and then filling just before it is ready to solidify, a smooth and perfect model may be obtained.

When the molds have been made some time before using they become so dry as to abstract water too rapidly from the fresh plaster used to fill them, and they should then have a coat of shellac dissolved in alcohol before oiling. A fresh coat of oil is necessary each time the mold is filled. When objects are too large to set in a bowl or other similar vessel a lead ribbon is a convenient substitute. A strip of thick sheet-lead, about six feet long and four inches wide, may be set edgewise on a sheet of paper, and bent around the fruit, and sand poured in as in any other vessel. Still larger specimens, like melons or pumpkins, require a sort of scaffolding of pieces of cardboard, thin wood, &c., built to support the edges of the mold, which must be constructed in many pieces, so arranged as to readily draw off from the model according to the shape of the specimens. After the model is made it must be thoroughly dried, which requires from three days to a week, according to size and temperature. It must then be soaked, or, if large, brushed over with boiled oil till saturated one-quarter to a half inch deep, and after the superfluous oil is wiped off allowed to dry a second time, when it is ready for painting.

The ordinary artists' brushes, colors, &c., are used for this work, the success of which depends entirely upon the skill of the artist and his ability to produce the desired effects. A convenient support to the fruit while painting is made by inserting a brad-awl where the stem should be—the brad-awl may be set in a wooden foot—and the model is finally completed by fixing in the hole left by it a stem made of a piece of copper wire, on which is molded gutta-percha to the proper size and shape.

Besides the fruit, the museum contains about 200 models and preparations of the more important edible and poisonous fungi. A much larger proportion of the various kinds of mushrooms, &c., are eatable than is generally supposed, but a prejudice has grown up from the want of knowledge concerning them that will take a long time to eradicate. Nevertheless, they contribute no mean portion of the food-product of the world. The Patagonians use large quantities of the *Cyttaria*, a fungus they collect and preserve by drying. In Germany and Italy mushrooms are in common use, and are of many varieties. In England and France the truffle and cultivated mushroom are among the delicacies of the wealthy. Although but one Agaric is cultivated among us, the Japanese grow several species on logs of decaying wood prepared in a peculiar manner, and, besides the home consumption, exported to China in 1874 to the value of $61,000.

We have received from the northwest coast immense specimens of *Polypori* and *Clavaria*, and from Sitka a bright red fungus, used by the Indians as paint, as yet undescribed. The curious subterranean production called tuckahoe, or Indian bread, common in the Southern States, is represented by specimens weighing more than four pounds. According to the analysis made by the department (see annual report, 1871), it is chiefly composed of cellulose and pectine. Its fruiting condition is as yet unknown, and its real affinities cannot, therefore, be described.

A few jars of fruit preserved as specimens in alcohol have long formed a part of the museum, and to these have been added a large number from the Centennial Exhibition. Some of these were filled with brine on which mold collects rapidly, and the fruit soon spoils. Numerous experiments on the preservation of fruit specimens made in the museum, prove that a saturated aqueous solution of borax with a few drops of corrosive sublimate is preferable to alcohol, causing less shrinkage and less discoloration, though no means of preventing the latter has been discovered. Such a solution will sometimes require filtering, but it is cheap and evaporates very slowly.

The specimens of fruit received from the Centennial Exhibition are from Australia, South America, and Japan. In the former country oranges and lemons are very successfully cultivated, seventeen varieties being exhibited at Philadelphia, of which, however, we have received but ten, as follows:

Oranges.—Common, Navel, Siletta, Seville, Mandarin, Poor Man's, Maltese Blood. *Lemons.*—Lisbon, Bergamot, Citron-fruit.

The Lisbon lemon is similar in form but of larger size than those usually found in our markets. The Bergamot is of the size and shape of a large smooth orange, and is evidently one of the varieties of Citrus limetta, some of which have sweet fruit. The citron or citrus medica is the fruit commonly sold in our markets in a candied state. Of the oranges the Seville is very large with rough surface, and a cavity in which the stem is inserted.

The Navel takes its name from a small protuberance on the blossom end, and is one of the kinds most highly esteemed in Brazil, where it probably originated. The Mandarin or Canton Mandarin is from China, has an exquisite flavor and a sweet eatable rind, but is of small size, from $\frac{3}{4}$ to $1\frac{1}{2}$ inches in diameter. The ease with which new kinds are produced from seed in the orange family renders it probable that as many varieties will shortly be cultivated as are now grown of the apple. Very few, however, have yet been described in books which are generally accessible.

In the Venezuelan collection are specimens of the chayote (Sechium edule), a cucurbitaceous fruit, cultivated in South America, which would no doubt grow during our hot summers. It is about six inches in diameter, with a rough rind, and is used like a squash. The collection from Venezuela also contains specimens of the various custard-apples and other tropical fruits of very large size.

The similarity of the climate of Japan to that of our own country lends to its productions a particular interest. From her exhibit at the Centennial we received twenty varieties of oranges, peaches, plums, figs, and persimmons, all of which are sorts peculiar to that country. Of the persimmons there are five kinds, from two to three inches in diameter, and their appearance fully confirms the descriptions given of what is undoubtedly the most valuable contribution made by Japan to our list of fruits.

FARINACEOUS SUBSTANCES.

Among the manufactured substances from the cereals or from fruits are many of the coarser food preparations that have become so popular of late. Wheat is shown in the natural berry with no other preparation than simply removing the hull, called "breakfast wheat." Then follow samples of steam-cooked and crushed wheat, and coarse and fine cracked wheat, one of the finer specimens bearing the trade-name "Nutrina."

"Hecker's farina" is a food preparation from wheat resembling finely granulated pearl barley, and pearl barley is represented by a full series of specimens, from finest to coarsest, the large sample simply with the husk removed, and preserving nearly the form of the grain. Avena is the coarsest of our food preparations from oats; the berry or grain is preserved in nearly its original shape, first having been hulled and then coarsely broken. There are numbers of grades of hominy, and all manufactured from white corn, from specimens with simply the hull and eye removed and in nearly its normal shape, to a very finely granulated product called "breakfast hominy." The coarser wheat-foods for animals are also included in the collection of "grits," as bran, shorts, shipstuff, middlings, &c., and the whole group numbers some fifteen specimens. In the collection of meals and unbolted flour there are sixty specimens, largely from corn, wheat, and rye. The corn-meals include coarse and bolted meal from yellow and white corn, with intermediate grades suited for the various purposes of culinary art. Samples are also shown from Turkey, Sweden, Argentine Republic, Chili, and Mexico. From British Guiana there is a series of meals from the sweet and bitter cassava, accompanied by the dried root from which they are prepared.

The collection of flour is quite large, and comprises not only the best grades of American flour, but many foreign specimens. Among the American specimens an interesting series of thirteen samples illustrates the manufacture of the "patent-process" flour from the uncleaned grain as received at the mill to the first grade flour, with all the intervening products, and the refuse and dirt (chaff, rubber dust, &c.) which is separated by the process of manufacture. Samples of self-raising flour and flour from desiccated sweet-potato and from rice (the last-named forming a very delicate food) are shown. In this group there are at present in the museum 64 samples.

The starch collection is quite large, and includes specimens from various countries and derived from different sources. In addition to the various preparations of food-starches by American manufactures from corn or other cereals, including maizena and the fancy preparations, similar series have been secured from other countries, even as remote as Australia and Japan. From South America interesting specimens have been received peculiar to that country, principally Brazilian and Venezuelan. The collection includes starch from the sweet and bitter cassava (*Jatropha manihot* and *janopha*), from the banana or plantain (*Musa paradisica*), from the sweet-potato (*Batatus edulis*) and yam (*Dioscorea bifidia*), ocumo starch (*Colocasia esculenta*), and arrowroot (*Mavanta arundinacea*).

Several specimens of starch were presented with the Mexican collection, among them starch from *Cicer vulgaris*, *Vicia fabæ*, *Phasseolus vulgaris*, *Pisum satioum*, and *Sechium edule*. This last named is an indigenous plant called "chayote," which is said to give a starch as pure as arrowroot, which is contained in the heavy "tubercular" roots. The plant also yields a fruit, which is of excellent quality. Its roots cannot be utilized until the second year. They can be removed without killing the plant, and the operation may be repeated for six or eight years.

With the Japanese collection a number of very interesting starches were secured which are peculiar to Japan. "Kudzu" is manufactured from the root of *Pueraria thunbergiana*. It is very abundant in certain localities, and yields the finest quality of starch. The root is frequently over five feet in length and as thick as a man's arm. For the manufacture of starch by the ordinary process of crushing the root and washing the starch and decanting it, however, the smaller roots, an inch in thickness and not more than a foot in length, are generally used. This starch is of a fine color, and its flavor is most agreeable. It is used as a mucilage by mixing with warm water, forming a firm, transparent paste. The "Kata-kuri" is another starch, made from the root of a species of dog's-tooth violet. A third kind of starch is prepared from the root of the fern (*Pteris aquilina*). Both of these starches are used as food, but the fern-root kind is also used in the arts, as it is capable of manufacture into a strong gum, or paste, called "shibu," by carefully mixing it with the sap of unripe persimmons (this fruit is described under the head of FRUITS AND VEGETABLES.)

After the starch has been extracted from the fine roots the fiber that remains is made into ropes, which are used to strengthen the mud-walls of buildings. There is nothing peculiar in the method of preparing the two last-named kinds of starch. All three species of plants grow wild, and are comparatively abundant. Starch-sugar is another product of Japan, millet and rice being used for its manufacture. The grain is first steamed, then mixed with a certain quantity of malt or ferment, and kept at a certain temperature for a number of hours in close vessels; the liquid portion is strained and concentrated by evaporation to a strong sirup. This is formed into bars when quite hot, forming a solid mass. Quite a collection of other allied starch products, as sago, tapioca, mandioca, &c., have been added to the museum. The two last named are of South American origin, and are the product of the cassava previously mentioned. The "farinha" of the Brazilian is manufactured from this root. To prepare it, the root is ground up, the juice expressed, and the remaining mass heated and dried in large iron pans over a slow fire. The juice of the bitter variety is extremely poisonous, but this quality is overcome and rendered harmless by heat. Farina from bread-fruit (*Artocarpus incisa*) is also shown, together with specimens of the above. For convenience in classification, the laundry and sizing starches, with similar products belonging properly to the section devoted to the arts and manufactures, have been placed provisionally with the "food products," as they form but a very small percentage of the collection of farinaceous substances.

Among the miscellaneous exhibits in this subsection there are several samples of a bread from Sweden which is particularly interesting. This bread is made of rye and wheat, prepared in large cakes the size of a dinner-plate; they are about an eighth to a quarter of an inch in thickness, are pricked with little holes forming indentations in the surface, and resemble huge crackers. The color is a dark brown, like well-baked bread-crust. It is made but once a year, and the batch is hung up in the loft of the peasant's home, strung in rows by means of holes left for the purpose. It is quite palatable, one variety being flavored with aromatic seeds.

A singular bread made by the natives of Santo Domingo, baked in rude cakes six or eight inches in diameter, is on exhibition here. It is manufactured from grated cassava, and has the appearance of fine sawdust slightly browned in spots.

SUGARS AND SIRUPS.

The native collection in this subsection is confined to specimens of Louisiana and Cuba cane-sugar refined within our own borders. Samples of a rude sugar manufactured by the Mexican Indians from the Labba cane, called Panocha, is worthy of mention as a novelty. It is formed in small cakes, not weighing over a pound, in little holes scooped in the ground. There is a large series of sorghum samples (raw and refined sugars and grades of sirups), illustrating the sorghum-sugar industry that sprang into existence during the war, and was a considerable source of revenue to the Northwestern States for a number of years. Within the last five years, however, no samples of the sugar have been added to the collection.

Beet-sugar is shown as the result of experiments conducted in this country, at Fond du Lac, Wis., at Chatsworth, Ill., and by the Sacramento Valley Beet-Sugar Company, in California. Specimens of the dried beet-root is also shown, with crystals of sugar, sugar-loaf, &c. In the maple-sugar series are exhibited sugar in cakes, granulated sugar, and sirups. One sample is shown from Vermont as white as "A" coffee sugar, and resembling it. The majority of samples are from the New England States or New York. The series of foreign sugars added to the museum have been quite large. The Australian collection embraces thirteen samples of cane-sugar from various Queensland manufacturers, and twenty samples of all grades of cane-sugar from New South Wales, furnished by the Colonial Sugar-Manufacturing Company. There are other samples also from Victoria, Tasmania, and South Australia. Cane-sugar has also been received from various localities in South America, the finest specimens coming from Brazil. Russia presented a collection of beet-root sugars numbering about twelve specimens, and smaller collections were received from various other localities. These, however, have not yet been placed in the museum. In the Japanese exhibit there are several jars of sugar, but it is not at present known from what source they were derived. A novelty in the sugar series is a sample made from corn.

BEVERAGES, LIQUORS, AND NARCOTICS.

The principal tea collection is a series of 150 samples in the original bottles, and under Japanese labels, secured from the exhibit of Japan at the Centennial Exhibition. Here are shown all grades of tea, marked with the price in Japan, in English characters, together with other substances used by the poorer classes as substitutes for tea, or it may be for adulteration. The collection is quite a valuable one to the museum, affording means of comparison and reference. Among other stimulants coming under this category may be mentioned maté, or Paraguay tea, (*Ilex paraguayensis*) and *Ilex cassina*, formerly used as a substitute for tea by the North Carolina Indians to make the celebrated "black drink." Coco (*Erythoxylon coco*) is worthy of mention in this connection. The leaf is used as a gentle stimulant by holding in the mouth or slightly chewing. In some portions of South America it is used with great advantage for sustaining strength in fatiguing journeys on foot.

Cocoa (*Theobroma cocoa*) and its many preparations are represented from various countries, one of the largest collections having been secured from the Venezuelan exhibit. There are twenty samples in this collection, and one specimen of the fruit in alcohol. The cocoa of Chuar, of which there is one sample, has the reputation of being the best in Venezuela, and has no equal in the world. Three specimens of chocolate are also shown with this series. Brazil also contributes a collection of cocoa, though somewhat smaller than the above, and there are a few other specimens from other localities.

Coffee (*Cafea arabica*) is shown in all its varieties, Brazil and Venezuela both contributing very large and complete collections. From the former a collection of over twenty specimens has been received, while the latter donated their entire collection, some twenty-five different kinds. It is principally shown in the berry, though two or three samples exhibit it in the husk or outer covering. From the Argentine Republic a small series was also received. In Venezuela 1,000 to 1,500 coffee-trees are planted on about one and three-quarters acres of ground, and a well-developed tree yields about half a pound of marketable coffee. Dwarf coffee (specimens shown) is the result of checked development in trees growing in poor soil, or it may result from dry weather. Laguayra, Maracaibo, and Puerto Cabello coffees are the best known of the specimens exhibited in this series.

Wines and liquors, though admitted in the classification, are not represented as a class in the collection. A few specimens from Russia and from Peru were presented. There are also samples of pulque from Mexico, manufactured from the liquor of agave. Tobacco, as a narcotic stimulant, is included in this subsection.

The American series comprises ninety specimens of pressed leaf-tobacco, representing twenty-one States, in various portions of the Union. The best sample is a Virginia tobacco that is said to have brought $4 per pound. With this series is another series of manufactured tobaccos (smoking, chewing, and snuff), showing the many forms of manufacture, and the kind of leaf used for the purpose. A specimen of wild Indian tobacco from Arizona is also shown. The foreign additions to the museum have been quite large, nearly every country represented at the Centennial presenting specimens of tobacco from their collections. The largest of these are from Brazil, Argentine Republic, and Japan. Cigars, cigarettes, and snuff were included among the donations. The foreign tobaccos, although on exhibition, have not yet been examined, though it is known the collection includes many interesting and valuable specimens. A few specimens of opium are shown in this group, as a narcotic stimulant. Its various other preparations as laudanum, &c., are shown in Section E.

SPICES, CONDIMENTS, ETC.

Here are grouped together collections of spices, showing in some cases how obtained. Nutmeg is shown from Java in its outer rind or covering, the same split open, showing the folds of mace, and lastly the nutmeg itself; the leaves of the tree are also shown. Ginger, cloves, cinnamon, and peppers in variety are shown from South America. Vanilla beans are exhibited from Mexico, and tonca beans from Guayama.

This series also includes the aromatic seeds, as anise, cardamom, cumin, &c., of which there are a number of specimens. The pot-herbs, or herbs of the kitchen-garden, are also included, together with the flavoring extracts. Among prepared sauces there are many samples of the celebrated "soy" (a Japanese condiment), and a few prepared American table-sauces. Olive-oil and its substitutes (pea-nut oil, &c.), are shown, together with "salad dressing," of which there are several preparations put up for market use. There are a great variety of preserved peppers from various parts of the world. Grated horse-radish, as prepared by a New York firm, is also exhibited.

ABORIGINAL FOODS.

As this series of specimens is more interesting taken collectively than when scattered through the different subsections of Section A, it has been given a subsection by itself. This collection is quite large, and illustrates to a certain extent the manner of livelihood of the North American tribes of Indians. Their cereal production is quite small, only a few specimens of wheat and similar grains having been added to the collection, and these principally from Indian Territory. Native varieties of maize are exhibited from New Mexico and Arizona; the specimens are small and are unlike any other maize in the museum. From one variety (a blue-colored corn) a kind of wafer bread is made. It is as thin as card-board, and a greenish-blue in color. It is made by spreading the dough thinly over heated stones, cooking it immediately, and when a sufficient quantity is made it is hung up in their wigwams with other food supplies. There are coarse breads made from the "kouse" and "kamass" roots, the former a bulb abounding in starch. The roots themselves are shown in natural state, and sliced and dried. A series of grass-seeds, numbering about twenty specimens, is shown; these are carefully gathered and preserved as food supplies, and generally eaten mixed with other substances, a favorite food being pulverized crickets (*Anabrus simplex*), and grass seed worked into a kind of paste or dough and made into a rude bread. Crickets and grasshoppers are, however, eaten in other ways.

The larvæ of a small fly found about Lake Mono in California are collected in quantities and eaten by the tribes in the vicinity. The manner of using pumpkins and musk-melons is to cut in long strips and then dry them. This food is prepared in large quantities and stored for winter use. By the Indians of Arizona the fruits of a species of cactus (*Opuntia*) and of *Yucca bacata* are carefully collected and preserved. Smaller fruits, as the blackberry, soap-berry, &c., are dried and preserved, sometimes kneaded into balls.

The Indians of Mexico prepare the agave in various ways. The tender inside leaves are roasted and preserved in large masses, or the fiber is removed and the edible portion pressed into thin, flat, black-looking cakes. A liquor (resembling pulque) is also made by them from its juice and called "mescall." The screw bean and mesquite bean are gathered and pounded into a very coarse meal, often without removing the insects (*Curculios*) generally found infesting the beans, and a very coarse bread made from it, which serves for a part of their winter supplies. An interesting specimen in the collection is a quantity of blue clay, containing a large percentage of magnesia. This is eaten with the native potatoes, which are about the size of bullets, and as they eat enormous quantities, the magnesia is supposed to prevent any unfavorable results from such gourmandizing. Among the nuts gathered for food, acorns and the fruit of the piñon are the most prominent, forming, with some tribes, a large percentage of their food, so that in years of scarcity of these nuts there is much suffering. Among some of the tribes a more civilized diet prevails, and peaches and other fruits are dried and preserved in the same manner as with the whites.

A specimen of jerked beef shows the manner in which the buffalo is utilized to furnish a winter supply of animal food. Those tribes raising corn or grain also store it against a time of need, after the manner of the whites.

SUBSTANCES USED IN ARTS AND MANUFACTURES.

Textile fibers.—The collection of textile fibers is so large and extensive that only a passing mention can be given here, as a full report on the valuable additions to our already large collections received in the last two years will make a volume of itself. In the series of animal fibers, there are about five hundred specimens of American wools, and these were selected with great care by well-known breeders in different parts of the country, and include the principal breeds of sheep with their crosses known to American sheep-husbandry.

The various manufactures from wool are also shown with complete series of samples, showing the different stages of manufacture. Thus are shown the kinds of wool entering into the manufacture of worsteds, flannels, clothing and piece-goods, carpets, &c. The foreign collections, especially from Australia, are equally fine, South Australia, Victoria, New South Wales, Queensland, Tasmania, and New Zealand, all being fully represented. Russian and other European wools were received, including fine collections from England. From the South American exhibits large collections were made, the most complete coming from the Argentine Republic. A majority of these wools are coarse and inferior, however, and used only in carpet manufacture.

The silk collection has been augmented by fine specimens of cocoons and raw reeled silk of *Bombyx mori* from many countries. The finest recent acquisition to this series is a large collection from Japan, and includes different varieties of Japanese cocoons and the silk reeled from them, many of the specimens being unique and interesting. The samples are not confined to *B. mori*, but include several varieties of silk from wild or oak-feeding varieties. One form of cocoon resembles delicate lace-work. Interesting collections were also received from South America.

The original or old collection of silk in the museum was quite complete, but the recent additions made it second to none in this country, and the equal of foreign museums.

Among the vegetable fibers the cotton collection includes specimens from nearly every cotton-growing region on the face of the earth, the largest series being four hundred samples from Egypt. About one hundred and fifty specimens of American cotton are shown as "lint," while another series illustrates the manufacture of cotton in this country, from the "homespun" of one hundred years ago to the finest products of the Manchester, N. H., mills, "peeler" cotton being shown step by step through the various stages of manufacture. Samples are also exhibited as manufactured by the government mills in Japan, and as rudely prepared by the natives of Chico, United States of Colombia. In flax a series of specimens from the flax-mills of Manchester have been added to the collection, showing the various manufactures. A series showing the result of experiments in cottonizing flax, as carried on during the late war, are still preserved among the flax collections. A few samples of flax were also secured from foreign countries. No new specimens of ramie have been recently added to the museum, though the old collection is quite full and entertaining, and gives the result of experiments in the South with this valuable fiber.

Jute is represented in a full series of specimens illustrating every stage of manufacture, and samples are shown, not only of the coarsest bagging, but of jute cloth and tapestry (the last of jute and cotton mixed), for upholstering purposes. *Apocynum cannabinum* is used as a textile by some Western tribes of Indians, and the museum specimens consist of stalks of the plant and raw and prepared fiber; there are also shown nets and fish-lines, sacks, baskets, belts, &c. The fiber is quite inferior, however, for most purposes.

A very complete collection of over one hundred specimens of New Zealand flax (*Phormium tenax*), illustrates the manufacture of that valuable product. The fibre is shown in all stages of preparation, and as rudely manipulated by the natives, who removed the woody matter by scraping with a shell. Among the manufactures are ropes, twine, fish-lines and fish-nets, halters, thread, coarse cloth, &c. Bagging is also made of it, and shown with mats and matting similar to that made from the Coir fiber. Some of the samples are very fine and in finish resemble linen.

Other foliaceous fibers are shown, as pine-apple, plantain, Manila hemp, Sisal hemp, &c., and a series of other agave fibers, showing the uses of this plant, such as coarse mats for saddle-cloths, brushes, &c. A beautiful collection of manufactures from *Agave sisalana* shows the delicate handiwork of the peasant women of Fayal, who use this fiber for the manufacture of their beautiful lace-work, which commands such prices in Paris. It was said by the donors that there were but twenty-five women on the island capable of producing this lace, as it requires practice from childhood.

There are about twenty specimens of malvaceous fibers, principally varieties of *Hibiscus*. *Abutilon avicennæ* is used to some extent by Indians, and is also used in the manufacture of brushes or dusters, a few feathers being inserted to hold the fiber in place. It dyes readily, but the colors are not fast. From the islands of the Pacific there is quite a series of Lace-barks and Tapa cloths (*Brousonetia papyrifera*), some of the last named already made into garments—if an article resembling a large paper bag, but open at both ends, can be called a garment. Some are stained with a dark coloring matter, and are checked off in squares or diamonds, like the figures of an old-fashioned quilt. Specimens of vegetable flannel are exhibited, said to be manufactured from the needles of *Pinus sylvestris*. Corn-husk is also shown made into a very good quality of toweling. It is also used as the fiber portion of oil-cloths. Asclepias fiber mixed with cotton is exhibited, with specimens of coarse cloth manufactured from it. The down from the seed vessels of this plant have been received as "vegetable silk." The substance is worthless, however, for purposes of manufacture.

A series of specimens of "silk-cotton" have been received from various localities in South America. Various species of bombax are represented, both free and in the seed-pod. It has no value as a textile, and probably could only be used for stuffing purposes. A few specimens of epilobum fiber are shown; its manufacture was only an experiment, however, no practical result having been obtained. It is therefore interesting only as a matter of reference.

From China there are a number of fibers which have been in the museum since its foundation, that were received without name and are therefore unknown, but by the aid of recent acquisitions from various other localities it is hoped they can be identified. They are manufactured into ropes, twine, and other articles of utility. The greater part of the Centennial collection of miscellaneous fibers have not yet been brought into the museum, so the specimens cannot even be mentioned by name. The collection is quite large, however, and contains much material that is new and interesting, and when eventually reported on in full, will be found to include many valuable specimens not met with hitherto in museums.

Paper materials.—The American series includes every known paper-making substance of any value, from the genuine *wood* paper, as manufactured for thousands of years by wasps, to the finest linen paper of the present day.

Among the less common substances may be mentioned paper from palmetto leaves, from leaves of *Yucca filamentosa*, from okra, from *Agave americana*, and from ramie. A very good brown or wrapping paper has been made from *Spartina cynosuroides*, a grass growing in marshes on the Mississippi, and samples from hay are exhibited from Colorado. The foreign collections represent most of our fiber-producing plants, showing the many sources from which this useful substance can be manufactured. Corn-husk paper from Austria and rice paper from

Japan are interesting novelties. The collection of Japanese and Chinese plain and fancy papers is quite a large one, and represents the entire paper industry of those countries, from the most delicate filmy paper used by jewelers for packing to the coarse heavy materials for screens or for wall decoration. The various writing and printing papers are exhibited, some of the former being very handsomely colored to represent birds, flowers, &c. Among other specimens are shown the papers used for handkerchiefs, &c., and as substitutes for window-glass; samples of imitation morocco are also exhibited. The Chinese papers in the museum are not so fine in quality as the above, though, it may be remarked, the series is quite small. The substances used are straw, mulberry, and bamboo; he straw and bamboo papers being quite coarse and inferior.

DYEING AND TANNING MATERIALS.

A series of interesting specimens in these two subsections were secured, and have been placed in the museum. Among the most noteworthy may be mentioned a number of specimens of madder from the Netherlands, comprising the root and different stages of its preparation. Samples of indigo are shown in the Japanese collections, and also from Venezuela, where it formerly was cultivated for export. Fustic-wood and dragons' blood are shown, with a great variety of unnamed woods, bark, and leaves used for coloring, principally from South America; the collections of Brazil and Argentine Republic being extremely rich in specimens of this group. Saffron and hollyhock flowers, annotto seeds and prepared annotto are also represented. Among mosses and lichens used for dyestuffs may be mentioned the different varieties of orchella weed (*Roccella*), from which the orchella paste is manufactured, samples of which are exhibited.

Canary rock moss, *Parmelia prelata*, and another form, *Umbilicaria pustrolata*, also belong to this series. Fungi used for dyeing is the old collection of the department received from Brazil.

The American dyes are represented by samples illustrating the manufacture of flavine from oak bark, indigo produced from native plants and by barberry root, orchella, cudbear, &c. Coloring matters of animal origin are represented by various specimens of chermes and cochineal, principally from South America. Dyes of mineral origin are represented by a large series of aniline dyes, both of American and Swiss manufacture, from coal-tar and petroleum.

An interesting series of tan-barks and other tanning materials of American origin were collected by the department for exhibition at the Centennial, and these have been added to the collection. Among the herbs and leaves lately discovered to be of value in this particular are *Ephedra antisyphillitica* and *Polygonum amphibium*. The tanning extracts from hemlock and oak barks are represented by specimens of the raw and concentrated extract. Of the foreign collections no particular mention can be made. The collections are quite large, however, particularly from South America, and are principally barks, woods, and leaves. From Turkey the department received an interesting series of oak-galls of different kinds, among them the "Aleppo galls" of commerce. Galls are used also for their coloring matter in the manufacture of ink.

GUMS AND RESINS.

Among the examples in this series may be named gum acacia (gum arabic), gum thus or frankincense, gum catechu, gum hyawa (*Icica* *heptaphylla*), orore gum (*Pithecolobium hymenæfolium*), gum tragacanth, gum from the "zapote" tree of New Mexico, gum dammar and copal, resin of *Xanthonhea hastialis* and from another species of this genus called "black-boy gum," gum anime (used for incense and to manufacture varnish), algaroba gum, &c. Among the interesting specimens lately received may be mentioned the "kawri gum" of New Zealand. It is used in the manufacture of varnish, and is an important article of commerce. The gum is found, at a depth of two or three feet under ground, over a large area of land which has been exhausted by kawri forests in past ages, and is now barren and almost unfit for cultivation.

Among the lacs or gummy exudations caused by the puncture of insects, from our own country, may be named that from the creosote bush (*Larra mexicana*) and the light-colored opaque gum of the *Opuntia*, both having been received from Arizona and Mexico. A specimen of gum from the *Brosimum galactodendron* has recently been received. The tree belongs to the same family as the bread-fruit tree, and when tapped exudes a thick milky fluid, which flows quite abundantly. It soon ferments, and the gum separates, leaving a liquor or whey which is of no value. It will dissolve in benzine, and when heated to 85° Fahr. it will pull like candy. It has a cheese-like smell when freshly cut, and is nearly white in color, growing darker with age. In Samoa it is used by the natives for filling the seams of their canoes. It has also curative properties, and has been used to a very limited extent in medicine. Several interesting gums and resins have been received from Mexico, under the Mexican names of "coapinole," which sells in the city of Mexico at one dollar a pound; "lechon," "xochicopal," an aromatic resin; "estoraque," used as an incense; "cuajiote," a gum-resin; "archepin," a gum-resin, used as a cement; and "brea," a very useful resin, the result of distillation of the turpentine from *Pinus teocote*, growing in the cold district of Mexico. It is used for making soap and in the manufacture of illuminating gas. "Tacamaca" is a resin, the product of *Elaphrium tomentoso*; "tescalama" is a varnish resin from *Ficus nymphæfolia*; "chicle," the resinous product of *Achras sapota*, is used for chewing, to increase the flow of saliva.

In the old collection of the department there is a small series of gum-resins from the valley of the Amazon, collected by Leuts, Herndon, and Gibbon, in a former expedition, but which are unnamed. Among the elastic gums are specimens of India rubber or caoutchouc, the product of *Ficus elastica*, gutta-percha, and balata, the last named from Venezuela. A new elastic gum from Mexico has received the name Durango caoutchouc. Like the genuine caoutchouc, it hardens with sulphur and receives a fine polish. Specimens of elastic gums from Brazil, and other portions of South America, have been added to the collection, but have not been examined.

FATS, OILS, AND WAX.

There are about half a dozen samples of vegetable tallow and wax in this series. One specimen of the last named, the product of Myrica, jalapensis, is received from Mexico. The vegetable wax of China and Japan (candles of which are shown) is produced from the fruit of several trees belonging to the genus *Rhus*. The most important of these is *Rhus succedanea*, and is grown extensively. *Rhus vernicifera*, the lacquer tree, also yields a wax, differing only in a slight degree from that of the wax-tree mentioned above. *Rhus sylvestris*, or the wild wax-tree, is also worthy of mention. Vegetable tallow is produced in Japan from the *Cinnamomum pedunculatum*. Other specimens of vegetable tallow and wax are from the valley of the Amazon. The oils are quite numerous, and, where it has been possible to do so, the vegetable products from whence derived are shown with them. Linseed and the more common oils have been received from various countries. The Russian collections included oils of anise, mustard, hempseed, walnuts, sunflower, wild rape, camline seed and poppy, with a few specimens of the refuse or oil cake. Oils of Japan are represented by rape-seed oil, which is used for illuminating purposes (*together with fish oil*) in Japanese households.

The South American collection is quite interesting, and includes "gingelly oil" (*Sesamum indicum*), "cocos oil," from the cocos-palm, "secua oil," (from a cucurbitaceous plant,) Seje oil, from another species of palm, crab oil, from *Carapa guianensis*, ground-nut oil, castor oil, &c. Linseed, ricinus, and cotton-seed oils are shown from our own country, the last named in connection with its principal manufacture, that of soap, a full series of which is shown. A valuable collection of essential oils was purchased for exhibition at Philadelphia, and these have since been added to the museum collections. Among them may be mentioned oils of hemlock, wintergreen, wormwood, golden rod, peppermint, spearmint, sassafras, pennyroyal, bergamot, cedar, oil of neroli, &c., the last named from flowers of *Citrus aurantiacum*, oil of sweet birch (bark of *Betula lenta*), and oil from roots and stems of several species of *Spiræa* are shown. Among the animal products in this subsection are many specimens of beeswax, both native and foreign.

A few animal-fats are also shown from South America; candles and soaps are also included in this group, limited collections of which were received from various localities. The mineral products are represented by series of coal-oils and petroleum, principally from our own country. Specimens of raw and crude paraffine are also exhibited, with some of the products of petroleum, as benzine, naphtha, &c. In this connection may be briefly mentioned a number of specimens of water-proof goods, canvas, leather, wood, &c., rendered so by paraffine in solution. They are impervious to water while freely admitting air.

NATURAL HISTORY SECTION.

About eighty specimens of ducks and chickens were secured for exhibition at the Centennial by the department, in addition to the regular museum collections. These have all been placed on exhibition, making the collection of domestic poultry most complete. Among these may be mentioned thirty-two specimens of a cross between the domestic duck and the wild mallard, purchased from the Smithsonian Institution. Another interesting cross was received a few years ago, said to be between the turkey and the guinea fowl. Other specimens similar to this interesting hybrid have been noted in the district, the department collection containing another specimen very like one mentioned above. It includes nearly all of the well-known varieties or fancy breeds, and as many of them were prize birds of pure breed they are true to name, and may be regarded as types. The collection of pigeons shows many of the fancy breeds of this adjunct of the poultry-yard. Though no new additions have been made to the fine series of small birds beneficial or injurious to agriculture, they have all been relabelled according to the latest authorities, and the specimens themselves brushed up and put in complete order. The poultry, game birds, and small animals have also been plainly relabelled, with both common and scientific names, so that visitors can to a limited extent answer questions for themselves. The collection of economic insects was so fully described in a previous report, further mention will not be necessary.

The fourth section of the museum (D), devoted to forest woods and specimens from the vegetable world purely botanical, is under the charge of the botanist, so cannot be reported upon here.

MISCELLANEOUS COLLECTIONS.

Vegetable substances used in medicine.—This collection, relating to a medical rather than an agricultural museum, is interesting in an economic view, and as many of our common vegetable products are used in medicine, either with the simple preparation of drying in the form of leaves, barks, or other portions of plants, or by resolving them into their approximate principles as quinine, &c., or extracting the medical properties in the form of tinctures or essences, &c., they are therefore given a place especially as they form a part of the vegetable kingdom, and reference is frequently made to them in answering general questions in the museum.

The first series of note in this group is a very valuable collection of specimens of the approximate principles of the following-named plants: *Salicine* from *Salix purpuzea; trilline* from *Trillium pendulum; scrophularine* from *Leptandra virginica; xanthoxyline* from *Xanthoxylum fraxineum; marrubin* from *Marrubium vulgare; gelseminia* from *Gelseminium sempervirens; daturia* from *Datura strammonium; arbutin* from *Arcostaphylos uvaursi; lobelina* from *Lobelia inflata; sanguinaira* from *Sanguinaria canadensis; podophyllin* from *Podophyllum peltatum; jenoia* and *veratroidia* from *Veratrum viride; helenin* from *Inula helenium; celastein* from *Celastrus scandens; phloridzine* from bark of *Pyrus malus; ricinine* from *Ricinus communis; berberina* and *hydrastia* from *Hydrastis canadensis; mannite* from *Leptandra virginica; sanguinaria sulphate* from *Sanguinaria canadensis;* salicylic acid from *Gaultheria procumbens*, and gelsemic acid from *Gelsemium sempervirens.*

In addition to this collection, there are examples of sulphate of quinia, quinidea, and cinchonidia from *cinchona;* sulphate of morphine, narcotine, &c., from the poppy, and many other products of similar nature; these samples are all of American manufacture. A large series of materia medica was received from South America, comprising roots, leaves, barks, and fruits in their unprepared state, with many of their products in the form of extracts, &c. Specimens of medicine are also included, and some of these are interesting, as they are peculiar to the countries presenting them.

SOILS AND FERTILIZERS.

The specimens in these two subsections were collected by the Chemical Division for exhibition at the Centennial. A full description of them was given in the monthly report of the department for May and June, 1876, from which the following statements are made:

The soils from the geological formations of different ages were collected under the supervision of the State geologist of New Jersey, Professor Cook, and illustrate the character of the soils common to the sections belonging to the several formations represented. The second division of soils, those formed directly from disintegration and decomposition of rocks, consists of a series of virgin soils collected by Professor Berthoud, of Cañon City, Colo., each of which was taken from a large area of known rocks, with no opportunity of admixture with *débris* from breaking down of rocks of a different character. They give a fair representation of the soils which these rocks are capable of producing.

With these specimens are also shown fragments of the rocks from which they were formed. Collections of marls, including green sand marl and the phosphatic marls from near Charleston, S. C., were made at the same time, and these are exhibited with the other museum specimens of this class.

The vegetable and animal fertilizers consist of muck, peat, marsh-weeds, sea-weeds, cancrine and fish scrap, pork cracklin, dried blood, &c. Specimens of bat excrement are also shown; this fertilizer is found in caves of some of the inland Southern States. The artificial fertilizers, which are made up according to the formulæ of the various manufacturers, from the natural fertilizers enumerated above, next follow.

The method generally employed in this branch of manufacture is illustrated by a series of products taken from different stages of the process as carried on by the Pacific Guano Company. The series consists of specimens of raw rock, the crushed and ground rock, sulphur, niter, and sulphuric acid, the rocks treated with acid, sulphate of ammonia, fish scrap, Stassfurt potash salts, and the mixture of the last four in the finished products.

Another series shows samples of the products put upon the market by different manufacturers.

MODELS OF FARM IMPLEMENTS.

No attempt at an exhibition of objects in this group has ever been made. A few specimens, however, have been received from time to time and placed in the museum. The first to be mentioned are a number of implements sent from China in 1864. Two forms of irrigating machines are shown, the difference being in the mode of applying the power, as one is intended to be run by men and the other by animals. A fan for cleaning grain is also shown, probably an imitation of an American or European fan. Models of smaller implements are also shown, as rakes, hoes, &c. From the Netherlands the department secured a collection of implements (models) used in cheese manufacture, which are very neatly made, and are quite interesting. These comprise all that are at present exhibited in this subsection.

DISEASES OF FARM ANIMALS—CASTS.

Among the contributions to the museum from the Centennial are seventeen anatomical models in plaster, colored from life, of the eyes, throat, digestive organs, &c., as they appear in cattle that died of the rinderpest or cattle-plague in 1867. These models were made and contributed by Dr. A. T. Verhaar, anatomical professor at the government veterinary school at Utrecht, Holland, and will prove of great value should this malignant disease break out in this country.

In conclusion, I would state that when the entire collections of the department are brought together, only a part of which have been briefly mentioned in this report, the museum will be of great value to the department and to the country. Much material was packed away in the storerooms of the department which should be placed on exhibition, in order that the various collections designated in the classification may be properly catalogued, and that more full and comprehensive reports on the various classes of objects may be made from time to time for publication and dissemination for the information of the people.

TOWNEND GLOVER,
Entomologist and Curator of the Museum.

To Hon. WM. G. LE DUC,
Commissioner of Agriculture.